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BIOLOGICAL SCIENCES IN BRITISH SCHOOLS

IN 1928 the British Association for the Advancement of Science published a report on the place of animal biology in the school curriculum. Since then, substantial changes have occurred in British education in general and in scientific education in particular. In view of these changes, Section K (Botany) of the Association suggested in 1949 that an inquiry into the present position in school biology would be desirable. As a result, the Council of the Association set up a committee to consider the position of biology and rural science in the school curriculum; its report has recently been published*.

Since biological science is changing rapidly, and since the trends in school practice are varied and important, the committee felt that its report must be considered as one of a series to be produced over the years.

The committee was made up of four professors of botany, a professor of horticulture, two university lecturers in zoology, a headmaster and a biology master from grammar schools, an inspector of schools and the directors of two professional biological associations. Since the inquiry was concerned with schools, it is difficult to understand why the committee did not include greater school representation; it is even more difficult to understand why no primary or secondary modern school representatives were invited to join the committee and why at least one representative of a girls' school was not asked to participate in its discussions. Apparently no consultation with Section L (Education) of the Association took place before the committee was constituted; its deliberations might have been more fruitful if such consultation had occurred. Nor is it easy to understand why the British Social Biology Council, an organization which, for many years, has devoted its attention to the teaching of biology in schools, was not consulted.

The report of the committee was based upon the assumption that factual information must first be obtained from as many sources as possible and that it should be presented together with constructive and realistic recommendations. By questionnaires and other means, inquiries were made in schools, in teacher-training colleges, field-study centres, and university departments of education and of the biological sciences. The inquiries have covered the whole of England, Northern Ireland, Scotland and Wales.

In primary schools, the majority devote some periods to simple biological work which often consists of observations of natural phenomena, and the time so devoted appears to bear a reasonable ratio to other subjects at this stage. Effective biological teaching would appear to exist in many schools not professing to teach biology, the appropriate subject-matter appearing in the curriculum as nature study, natural history or health education. Little evidence has been obtained of the purposeful linking of biological teaching with other subjects, such as

* *The Advancement of Science*, **10**, No. 37 (1953).

geography, or of its evaluation in relation to rural science.

In contrast to such class-room activities in primary schools, field-work appears to occupy a very small proportion of the time allocated to biological studies. Nature walks form a part of many schemes. Many schools keep rabbits, poultry, bees and other 'domestic' animals, and school gardens, tended by the pupils themselves, provide a useful source of practical work. In only a few schools do out-of-school clubs exist in which pupils can develop hobbies having a biological bias.

Very few primary schools possess special accommodation for biology, and simple equipment for much-needed and valuable experimental work is also lacking. Only a few of the teachers responsible for biological teaching in primary schools have taken biology as a training college subject; the majority have no such special qualification. In too many instances, less effective work in the biological field is undertaken in primary schools than is both possible and desirable.

From these observations, the committee recommends that, in primary schools, teachers should stress the relationship of biological studies to problems of everyday life and should so adjust their teaching as to make more clear than is now usual such inter-relationships, and particularly the co-ordination of biological topics with such subjects as geography and hygiene. Outdoor work by pupils should be encouraged, and heads of schools should foster suitable clubs, such as natural history societies and young farmers' clubs. Heads of schools should facilitate the work of their staffs by granting some relief for the preparation of practical studies and outdoor work. Those who teach biological subjects should be encouraged to attend suitable refresher courses to improve and extend their knowledge.

In secondary modern schools there is a great shortage of well-qualified biology teachers and, as the committee observes, there appears to be little hope of improvement in the near future. The recommendation, therefore, that all courses in science in secondary modern and secondary technical schools should include biology and that biology should be taught to both boys and girls appears to be compounded of hope rather than conviction. The other recommendations for secondary modern schools follow along the same lines as those put forward on behalf of primary schools.

The main part of the report is concerned with secondary grammar schools, and here the committee treads ground which appears to be more familiar to it. In these schools many complaints were aired Biology teaching is too much confined to text-book studies with a consequent neglect of the living organism studied as an entity and a too common substitution of preserved specimens and morphological details for vital studies. In both urban and rural schools this too close attention to text-book studies has resulted in neglect of field-work even to the extent that students are entirely ignorant of common plant and animal names; few students know how to obtain these names for themselves.

During the past forty years, marked changes have taken place in the pattern of biology teaching. Since the First World War, the number of secondary grammar school pupils studying some form of biology at school certificate level has increased about seven times for an increase in the total number of candidates of only about three times. During this period the increased emphasis on general biology has resulted in more balanced courses than those which were almost exclusively botanical. At the higher school certificate level the increase in the number of biology candidates has reached seventy times that of 1918. More girls than boys study biology in secondary grammar schools; the higher proportion of girls taking biology in school certificate is partly due to the fact that fewer girls' schools teach chemistry and physics.

Several reasons are given for the small proportion of boys studying biological subjects. The opportunities offered by industry to chemists and physicists, for example, tend to divert students to these sciences. At higher school certificate level the ratio of girls to boys taking biological subjects is approximately unity, however; the increase in numbers of boys is partly due to those hoping to gain exemption from pre-medical university examinations by passing at the higher level.

Probably the most serious statement reported by the committee is that dealing with trends and standards in secondary grammar schools. While it is almost impossible to determine accurately changes in the absolute standard of teaching and the average ability and performance of students, there seems little doubt that both the quality and the quantity of biology teachers has rapidly deteriorated of recent years. Meanwhile, the total number of pupils in secondary grammar schools has increased. These increased numbers have resulted in dilution with mediocre students who must inevitably reduce the standards over the whole country, even though examination statistics give no evidence of this. During 1946–50 the percentage of awards in public examinations shows no change, and it is difficult to resist the conclusion that an arbitrary statistical adjustment is being made.

If, as the committee believes, the average quality of secondary grammar school pupils is declining as numbers increase, this procedure means an automatic fall in examination standards. Some examining boards confirm the effect of dilution and the deterioration of the quality of teaching. The committee recommends that an attempt should be made to obtain estimates and maintain records of absolute standards of performance in all external school examinations in order that trends may be revealed, the more so as trends in both numbers and standards may have been considerably affected by the introduction of the general certificate of education. It is also suggested that, if any medical school exempts students from any part of the statutory pre-medical examination in science before admission, passes at the advance level in physics, chemistry and biology of any recognized examining body should suffice for such exemption.

A useful section of the report is that dealing in some detail with the teaching of field-work, horticulture and rural science in schools. One of the most valuable suggestions is that biology should rank as a subject for third-year courses of study at training colleges, with attendance at residential field-centres included as a vital part of the syllabus. It is also suggested that, wherever possible, practical field-work should be an integral part of the curriculum throughout the school; sixth forms (especially of schools in urban areas) should attend at least one week's course at a residential field-centre during the year. This, like a number of the committee's suggestions, is scarcely realistic, and greater emphasis might have been placed on the value of field-work initiated and carried out by the pupil's own teacher. To be fully effective, field-work should be carried out continuously throughout the year and in an environment not only with which the pupil is familiar but also in which he is likely to remain for some time so that his interest may be continuously stimulated and encouraged.

In a section on the supply of biology teachers in schools, the committee notes with some concern a report which stated that during 1948–49 only 38 per cent of vacancies in biology were filled satisfactorily. The same source provides evidence that the quality of the staff is also declining. It would appear that about fifteen grammar schools each year are dropping biology, while almost fifty more schools are employing teachers having no university biological training. The estimate by the Hankey Committee that, by 1954, a surplus of biology graduates may be expected even after teaching requirements have been met is strongly contested by the committee, which questions the validity of the various criteria on which the estimate is based.

The report also discusses the supply and remuneration of laboratory assistants in schools, and gives some useful hints on methods of teaching biology in schools. This section contains little new and is mainly a restatement of principles already well known to teachers of biology and other subjects. Here new ground might have been broken if the committee had devoted some time to the teaching of biology to the rapidly increasing number of students who are being given time off from their everyday work in industry and commerce to attend general educational classes.

There is a great danger that this important report may be put on one side. The frequent pleas that local education authorities should spend money in sending teachers and students on courses, employ more teachers and laboratory assistants and provide more and better equipment will be unavailing unless they carry the conviction that these proposals really are most desirable and necessary in the building up not only of scholarship but also of character among British citizens. Unfortunately, the form and presentation of the report is much too stereotyped. It would have carried greater weight with government and local education authorities if it had been written with more force and conviction—as if the committee really believed, for example, that a greater extension of biological knowledge has something to contribute to the promotion of happiness among human beings by helping to dispel fads and superstitions which rule the lives of the majority of men and women and which rightfully belong to a period of history long before the advent of modern science. The committee might well have referred to the £47 million spent on drugs in Britain under the National Health Service last year and the savings that could be effected with the spread of biological knowledge; most of these drugs were taken by people, many of them belonging to the so-called educated classes, who have little knowledge of the working of their own bodies. The amount of money spent each year on prepared and patented foods might also have been mentioned.

This is an age of reports, and, in days of educational economy, the only ones which pass beyond the files are those which are alive with truths so challenging that action becomes desirable and compulsive. Others turn out to be mere intellectual exercises.

A GEOPHYSICAL MIXTURE

Advances in Geophysics

Edited by H. E. Landsberg. Vol. 1. Pp. xi+362. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 7.80 dollars.

THIS volume contains eight articles covering a wide range of geophysical topics. The first two are on the automatic processing of data and on new statistical techniques; there follow a review of the general circulation of the atmosphere and two articles on the upper atmosphere. The remaining three articles are on estuarine hydrography, the earth's gravitational field and aeromagnetic surveying.

It is clear that in such a wide selection of topics almost everyone will find something to interest them; but it is perhaps not equally clear that many people will be interested in a sufficient proportion of the contents to pay 7.80 dollars for the volume. Some of the contributors seem not to have had a very firm view of the audience for which they were writing. For example, the first seventeen pages of Woollard's article on gravity contains material which can be found in any text-book, while the remaining twelve pages are devoted largely to tables concerning the values of gravity at national base stations. Woollard's work that is here summarized is of the greatest interest and importance for geodesy and geophysics; but it seems doubtful if a review article is the best place for the detailed tables, particularly when it is coupled to the rather elementary introductory matter. It is perhaps worth mentioning that Table 5 appears to ascribe large errors to the early measurements at Dehra Dun by Lenox-Conyngham and by Hecker; in fact, their results agree excellently with the modern determinations quoted later in the article.

The article on aeromagnetic surveying is remarkable in giving specimens of actual surveys of which there are few published examples. It also gives an estimate of the cost of the work as 10 dollars per flight mile without Shoran or 20 dollars per mile with Shoran, and estimates that 7,000–10,000 miles can be worked per month. A large aeromagnetic survey is clearly not to be undertaken lightly.

The first of the meteorological articles is an account of the general circulation of the atmosphere by B. Bolin. This gives a compact account of the present state of the subject, including very clear diagrams illustrating the form and seasonal movement of the stream lines. The second meteorological article is an account by F. L. Whipple of the exploration of the upper atmosphere by the observation of meteors. This is a most welcome summary of a rapidly developing subject by one who has been responsible for many of the recent developments. It includes a fine photograph of the new super-Schmidt meteor camera that Harvard College Observatory is operating in New Mexico. The remaining meteorological article is a discussion of some unsolved problems of the high atmosphere by N. C. Gerson.

The statistical article by A. Court is mainly concerned with the frequency of occurrence of extreme values of a variable. This is often of considerable importance in such problems as the design of structures to resist wind or earthquakes and in agricultural planning.

The article by J. C. Bellamy on the automatic processing of data discusses recent developments in digital and analogue data-handling equipment and the methods available for the visual presentation of large quantities of information.

The article on estuarine hydrology by D. W. Pritchard deals mainly with the equations of motion of the water.

As a whole, the book contains much information that is not easily available, and should help to stimulate interest in many of the important matters that it discusses. E. C. Bullard

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RANDOM CHOICE IN THE CHEMOTHERAPY OF TUBERCULOSIS

The Bacteriostatic Activity of 3500 Organic Compounds for *Mycobacterium tuberculosis* var. *hominis*
By Guy P. Youmans, Leonard Doub, and Anne S. Youmans. (Chemical–Biological Coordination Center, Review No. 4.) Pp. v+713. (Washington, D.C.: National Research Council, 1953.) 5 dollars.

PROF. and Mrs. G. P. Youmans and Mr. Leonard Doub are well known for their work on the chemotherapy of tuberculosis, and one looked forward with interest to reading the results of their collaborative efforts. As stated in the foreword, the present volume describes the techniques used in the *in vitro* and *in vivo* screening of three thousand five hundred compounds for their action against the tubercle bacillus, together with the results of these tests. The positive results as embodied in this volume may not unfairly be described as meagre. However, as one of the main reasons for their publication was that it might obviate unnecessary testing of the same compounds by other investigators, one must record one's appreciation of the enlightened action of the firm of Parke, Davis and Co. The work recorded here involved heavy expenditure in money and energy, and one hopes that the example of Parke, Davis and Co. in publishing unsuccessful results may be followed by other commercial firms in this and other fields. The book contains a brief introduction, followed by chapters on, respectively, rationale for the *in vitro* and *in vivo* screening programme, experimental methods, and discussion of selected data in relation to chemical structure. The fourth and fifth chapters embody the results of tests in mice and in the test-tube, respectively, the latter chapter occupying six hundred pages and containing also a formula and an alphabetical index. The printing is clear and accurate, and structural formulæ are set out with an impressive lack of restraint in regard to space.

The aim of an investigation, such as is described in this volume, is, simply stated: to discover or invent a chemical remedy which will eradicate, completely, virulent tubercle bacilli from human tissues without causing injury to the host cells. The natural approach for the chemist would be to design or select molecules likely to become involved in the bacillary metabolism. As the authors point out, our present limited knowledge of the metabolism of the tubercle bacillus does not lend much encouragement to this line of attack. They accordingly believe that the only method that offers promise of early success is random screening, and they do not hesitate to claim that there should be no basis for selection of compounds other than availability. The sentence—"The random selection of compounds to be tested should be adhered to as strictly as possible"—has a kind of lunatic flavour about it.

Finding *the* chemotherapeutic agent for tuberculosis is a difficult problem, but it will scarcely help the search to throw reason to the winds. There are known nowadays a number of widely different types of molecule of synthetic and natural origin which exert a considerable suppressive effect on the tuberculous process in man and in animals. This knowledge provides a rational starting-point for 'structural tailoring' which may lead to the production of substances of greater activity and lower toxicity. Alternatively, an intensive study of the mechanism by which any one of these substances interferes with the metabolism of the bacillus may provide an important clue which would guide further synthesis. This will be a difficult but perhaps not unrewarding investigation. If a greater proportion of the resources, which have been used by commercial firms in screening potential antitubercular substances, were diverted to the study of the chemistry and biochemistry of *Myco. tuberculosis*, progress would be eventually more rapid.

Chapter 1 gives a full description of the *in vitro* testing routine, and it is surprising to find American workers placing such reliance upon it. Compounds are tested in Proskauer and Beck's synthetic medium, and the results are used to correlate chemical structure with bacteriostatic activity. Some parallel tests are carried out in the same medium enriched by 10 per cent beef serum. This makes possible the elimination of a large proportion of compounds showing high activity in synthetic media, an activity which is considerably reduced by serum proteins. The authors point out that the reduction of "bacteriostatic activity may at times be more a function of the stimulation of growth than inactivation of the agent by combination". It is worth remembering also that "stimulation of growth" may be due to some extent to altered metabolism of the bacillus in the presence of serum proteins which would render the chemical agent innocuous. The views expressed on the conduct of tests in laboratory animals and the limited deductions which can be drawn from these experiments are eminently sensible.

Of the three thousand five hundred organic compounds tabulated, only 184 were tested in experimental murine tuberculosis and, in all, eleven were shown to exert a suppressive effect. Included in these eleven active compounds are streptomycin, viomycin, chloromycetin, *p*-aminosalicylic acid, 4,4′-diaminodiphenyl sulphone, nicotinamide and three thiosemicarbazones. Since the discovery of activity in these compounds by various workers was attained by following a lead, however slender, the heroic empiricism of the method of random selection does not inspire confidence. The *in vitro* table records the minimum concentration (mgm. per 100 cc.) which causes complete inhibition of growth for fourteen days of the *H37Rv* strain of *Myco. tuberculosis*. For the most part, the test in serum-enriched media "was run at the arbitrary compound level of 10 mg.%". This procedure very much reduces the value of the data, since it is highly important to find out the minimum concentration of the chemical agent which will inhibit growth in this medium. Furthermore, the extent to which the minimum inhibitory concentration measured in a synthetic medium is increased by the presence of serum is a very valuable indication of the probable activity of the agent *in vivo*.

One hopes that these criticisms will not seem ungracious and that in subsequent reports the maximum information will be extracted from the experimental work. VINCENT C. BARRY

ABELIAN MODULAR FUNCTIONS

Funzioni Abeliane Modulari

Lezioni raccolte dal Dott. Mario Rosati. Per Fabio Conforto. Vol. 1: Preliminari e parte gruppale; geometria simplettica. Pp. 454. (Roma: Edizioni Universitarie Docet, 1951.) 3900 lire.

ABELIAN modular functions are functions analogous to the elliptic modular function $J(\omega)$, but involving a complex matrix variable instead of a single complex variable. Such functions stand in a similar relation to the Abelian functions (meromorphic $2p$-periodic functions in p complex variables) as $J(\omega)$ does to the elliptic functions.

The first volume of the present work begins with a short discussion of the elliptic case, and an excourse on matrices. Then the Riemann matrices of Abelian functions (that is, the matrices formed by the period vectors of such functions) are studied and connected with the classification into distinct fields of Abelian functions. Every Riemann matrix is reduced to a normal form involving $p - 1$ integers and $p(p + 1)/2$ complex parameters subject to certain inequality conditions. The real and imaginary parts of these parameters are interpreted as co-ordinates in a $p(p + 1)$-dimensional space; the inequalities determine then a region R in this space which, in the elliptic case $p = 1$, is the upper complex half-plane. From the reduction of the Riemann matrices one is immediately led to the simplectic group, on one hand, and to the infinitely many distinct modular groups contained in it, on the other hand. Both types of groups are isomorphic to groups of transformations of R into itself. In particular, the simplectic group generalizes the well-known group of fractional linear transformations of the upper complex half-plane into itself, while the modular groups generalize the classical elliptic modular group.

The author studies the simplectic group in great detail and deals especially with its geometric properties. These results are finally applied to the modular groups, which are shown to be discontinuous in R and to possess fundamental regions derivable from the reduction theory of quadratic forms.

A great deal of the material of this book is due to C. L. Siegel, and the author follows his example in using matrix notation. This gives the theory a particularly elegant form and makes this one of the best books published in recent years on any subject in advanced mathematics. The print is a photographic reproduction of a handwritten manuscript and suffers a little from the drawbacks of such a method. Fortunately the calligraphy is excellent.

K. MAHLER

PROTOZOOLOGY

Traité de Zoologie

Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 1: Protozoaires; rhizopodes, actinopodes, sporozoaires, cnidosporidies, Fascicule 2. Pp. ix+1160. (Paris: Masson et Cie., 1953.) 9,935 francs.

THE great and courageous enterprise of Prof. Pierre-P. Grassé's "Zoological Treatise" has been carried another important step forward. As the story of the Protozoa unfolds in this second part of the first volume, one cannot help being impressed by the magnitude of the task undertaken by Prof. Grassé and his team. To the imposing series of volumes already doing their well-appreciated duty, yet another one has been added, and it may at once be gratefully acknowledged that it is as worthy in succession as it is full of promise for the future.

The Rhizopoda, Actinopoda, Sporozoa and Cnidosporidia are dealt with by a team of authors recruited from a variety of seats of learning in France and French North Africa. The contributors are M. Caullery, E. Chatton, G. Deflandre, P.-P. Grassé, A. Hollande, J. le Calvez, J. Pavillard, R. Poisson and G. Trégouboff. The contribution by E. Chatton is posthumous, and has been edited and supplemented by Prof. Grassé.

The present volume contains more than a thousand pages of text illustrated by 833 text figures and two coloured plates. The high quality of the line drawings and plates and of most of the photomicrographs are a credit to authors and printers alike. Among the illustrations are encountered a good number of old friends that have become classics. One would deplore their absence. Many have been redrawn, and this rejuvenation materially adds to their usefulness. The general standard of lettering and legends is high, and data concerning magnifications are a very welcome asset to quite a number of the illustrations. One would wish they were present in all. A good subject-matter index of fifty pages and a list of contents are appended. There is also a list of errata and addenda.

The wide range of protozoology covered in this volume makes a detailed scrutiny of its academic merits and its up-to-dateness well-nigh impossible. A considerable proportion of the forms described in

this part of the work are parasites, and this extends the sphere of its usefulness beyond the confines of academic zoology into the realms of applied biology and medicine. Thus, a considerable body of recent research claims a place in a work of this type. A survey of the lists of references is reassuring. For example, of the 169 references on the Hemosporidia, 82 are dated from 1940 onwards. However, the authors have not yielded to the temptation to weight the volume unduly on the applied side of the subject. The chapter on malaria, for example, is concise and, although it contains a modicum of information on anti-malarial drugs and on the vectors and their control, it does not disrupt the balance and continuity of the zoological approach.

In general, the treatment of the various groups is well balanced, half of the volume being devoted to the Rhizopoda and Actinopoda, and the remaining half to the Sporozoa and Cnidosporidia. A chapter on the cytology of the Acantharia and Radiolaria is presented as an addendum. It calls on recent results of work by A. Hollande and M. Enjumet to provide a means of supplementing the treatment of problematic questions concerning the interpretation of cell structures and life-cycles in these two groups. This is just one of the examples of the care with which the authors are attempting to minimize the risk of early obsolescence which so often detracts from the value of works of this nature and scope. Style and presentation are lucid throughout, and should not present any undue difficulty to the English-speaking reader. Zoologists the world over owe a great debt of gratitude to their French colleagues for a truly indispensable book.

Otto Lowenstein

THE COUNTRY NATURALIST

Birds of the Field
By James Fisher.

Butterflies of the Wood
By S. and E. M. Beaufoy.

Flowers of the Wood
By F. M. Day,

Birds of Town and Village
By R. S. R. Fitter.
(The Country Naturalist Books.) Pp. 36+32 plates each vol. (London: William Collins, Sons and Co., Ltd.) 3*s*. 6*d*. net each.

MESSRS. COLLINS, whose "New Naturalist" series of books made a special niche for themselves both in book production and in the literature of natural history, are now issuing a new series under the general title "The Country Naturalist", which one presumes can be looked upon as a shortened and cheaper form of the "New Naturalist".

James Fisher, one of the editors of the "New Naturalist" series, is the editor of this new series, so both lay and professional naturalists can rest assured that the new venture is being well looked after and that the best possible author for each topic will be selected.

The objective of these new books is to present a well-illustrated and popular introduction of each topic to non-professional readers; though it is difficult to imagine the informed field naturalist and certainly the biologist not finding much of value and interest in each book.

The method of approach is ideal for the readers whom the editor has in mind. As he points out in his introduction, Great Britain, with its varied geology and climate, presents an intricate patchwork of woods, fields, moors, mountains, towns and rivers, with a margin of sea-coast of comparatively great length and complexity. Since each of these types of country supports its own peculiar communities of plants and animals, the obvious way to approach the study of our flora and fauna (especially from the initial point of view of identification) is through these divisions; though no doubt the various authors will realize that there is much overlapping in Nature and therefore will not confine themselves too rigidly to organisms specially adapted to, and therefore found exclusively in, the selected area. Judging from the first four books, there is to be no risk of this.

James Fisher starts the series himself with "Birds of the Field". He begins by explaining his method of selection with which no one can disagree, and then he plunges straight into his descriptions of birds to be found, classifying them in their accepted families such as those of the crow, starling, weaver, etc.—fourteen in all. The text is just what one has learned to expect from Fisher's pen—descriptions by a well-known expert and well-trained observational ornithologist who fortunately has the rare gift of analysis and interpretation which the untrained mind can not only grasp but also finds fascinating. All the thirty-two full-page plates are photographs, mostly illustrating one species in its natural surroundings, occasionally two. Sixteen are delightful colour-photographs. All the photographs have been taken by well-known colour-photographers.

S. and E. M. Beaufoy were a good choice for "Butterflies of the Wood". Their method of approach is similar to that of Fisher's. Again there are thirty-two plates of illustrations; but here it is possible to present twenty colour-photographs and eighty-one photographs in black-and-white.

F. M. Day's "Flowers of the Wood" is in the same vein, though here the introduction is longer, taking the form of an excellent essay on British woods. Well-known flower photographers have contributed seventeen colour- and nineteen black-and-white photographs which make up the thirty-two plates.

Finally, none other than R. S. R. Fitter, who charmed thousands of readers with his "London's Natural History" and also wrote the "Pocket Guide to British Birds", has contributed "Birds of Town and Village" to the series. His methods of dealing with his topic are similar to those of Fisher and the result is equally as good. His text is illuminated by thirty-two plates carrying twenty colour- and twenty-two black-and-white photographs.

In none of these books is the text confused with unnecessary technical terms or scientific names. In each case, however, a classified list of scientific names, following the most recently accepted rules for zoological and botanical nomenclature, is appended.

We note that among other books in preparation are "Flowers of the Seaside" by Ian Hepburn and "Birds of the Seaside" by James Fisher, and many more are on the way. This is good news, because here is an excellent series. James Fisher the editor, all the authors, and Collins the publishers are not only to be congratulated but also thanked for making available to everybody such books of convenient pocket size and at a price that anyone can afford.

L. J. F. Brimble

Studies in Logic and Probability

By George Boole. Pp. 500. (London: Watts and Co., Ltd., 1952.) 25*s*. net.

IF we accept the point of view of such eminent authorities as, for example, Whitehead and Russell that mathematics has its very roots in the principles of logic, even down to the most formalistic levels, it is not surprising that the attempt should have been made and continued to reinforce the somewhat open structure of probability theory by the application of the indisputably rigid rules of logic. Indeed, there arises a peculiar philosophical satisfaction from the display of the conjunction of the unassailably true laws of logic and of statements of something which one would ordinarily say is 'only probable'. True, the degree of being 'only probable' in the general conversational sense has been refined to a high degree of near certainty by the mathematics of the subject, but, even so, the essential uncertainty character inherent in all 'probability' remains.

The present volume applies the rules of both formal and symbolic logic to the study of mathematical probability theory, and it consists of the author's miscellaneous writings on logical subjects and his papers on related questions of probability. The period embraced by the papers is from 1847 to 1862, the latter year antedating the author's death by but two years. The book is a companion volume to "The Laws of Thought", which was first published in 1854 and reprinted in 1916 and 1951.

During recent years there has been a recrudescence of interest in applied logic and in Boolean algebra, notably perhaps in the industrial field, in connexion with the design of electrical switching circuits. This book should be welcomed by workers in that branch of endeavour as well as by those to whom it will appeal by its title subjects. S. A. S.

General Network Analysis

By Prof. Wilbur R. LePage and Prof. Samuel Seely. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. vii+516. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 68*s*.

THIS book gives a general and unified treatment of networks (electrical circuits), suitable for advanced work in either power or communications. There is also some filter-design theory. Each topic is developed from the fundamental principles, but it is assumed that the reader has already taken an elementary course in the subject. The first chapter explains the use of complex numbers. The second and third give a general treatment of networks, based on Kirchhoff's laws, and using determinants, a knowledge of which is assumed. Series and parallel circuits are considered simultaneously, and stress is laid on the duality between junction and loop analyses. Some of the terms are new—for example, copedance and comittance. The fourth chapter, based on Ampère's and Faraday's laws, introduces magnetic coupling and forms a link between the points of view of communication and power engineers. Chapters 5, 6 and 7 apply the general theory to networks restricted in some way—for example, four-terminal, lumped or selective. Matrices are defined and explained before being applied. In Chapter 8 previous results are extended to polyphase systems, using the method of symmetrical components. The remaining six chapters discuss respectively circuits with distributive properties, impedance and admittance charts used in the design of transmission lines, Fourier series, transients in linear systems, the Fourier integral, and the Laplace integral applied in the operational calculus. The book concludes with a bibliography, two mathematical appendixes, but without the answers to the numerous examples for solution at the end of each chapter. It is a pity that the very high price may restrict the use of this interesting treatise. H. T. H. PIAGGIO

Elements of the Topology of Plane Sets of Points

By Prof. M. H. A. Newman. Second edition. Pp. vii+214. (Cambridge: At the University Press, 1951.) 27*s*. 6*d*. net.

THE first edition of this book has for long been regarded as a standard introduction to the ideas and methods of topology.

In the second edition, substantial changes have been made, resulting in the rearrangement of the contents of Part 2 of the first edition. Thus Chapter 6 gives the 'homology' theory of simply- and multiply-connected domains, and Chapter 7 the 'homotopy' theory (paths and their deformations). The author states in the preface: "The treatment of homology on a grating has been modified so as to make clear the distinction between 'chains' and their point-set loci. The sections on boundary elements of domains, and on the connectivity of certain kinds of closed sets, have been omitted, and their place taken by a section on the orientation of plane curves. A number of topics, such as the properties of vector spaces of infinite dimension, the Jacobian theorems on implicit functions, and the Cauchy integral theorem (with one or more boundary curves), are treated as examples".

Part 1 remains practically the same as in the first edition, and consists of chapters on sets, closed and open sets in metric spaces, homœomorphism and continuous mappings, connexion, and separation theorems. The second edition is likely to become even more a standard work than the first edition.

R. G. COOKE

A Sanctuary Planted

By Walter J. C. Murray. Pp. 191+33 plates. (London: Phoenix House, Ltd., 1953.) 15*s*. net.

THIS book describes the evolution of a scheme, perhaps one should say a dream, by which a plot of unexciting ground was turned into a little Paradise, a sanctuary for birds, beasts and insects, where lovely wild flowers could flourish and shy birds could come to breed. The busy schoolmaster found joy and relaxation in his planting and planning, he learnt of the things attractive to birds, what trees and shrubs they prefer and of the necessity for food, shelter and water, particularly the last. He tells of his struggles and successes, of the Sanctuary through the changing seasons, of sunshine and storm, of its plants, insects, birds and animals and of its many delights. His experiences will aid others likewise bent on converting a waste corner of the garden, some old shrubbery or other piece of land into a place of delight. The author gives at the end of his book a helpful list of trees and shrubs that he has tried, with notes on flowering time and purpose. His photographic illustrations, from the colour snapshot on the jacket to the many black-and-white pictures in the book, are testimony to his skill with a camera. The photographs of different birds, including the bullfinch and the chaffinch bathing, are particularly good, and so are the butterfly pictures.

FRANCES PITT

GEORGE BERKELEY, 1685–1753

THIS bicentenary year of Bishop Berkeley's death is being marked by a quickened interest in his life and writings. The outward signs of this are several; one is a special number (May 1953) of *The British Journal for the Philosophy of Science* wholly devoted to his scientific and philosophical papers. In addition, a set of contributions dealing with some specialist aspects will be found in the *Acta* of the Eleventh International Congress of Philosophy (1953). Manifestly, these represent more than a desire to pay tribute to a great man; they express a conviction that Berkeley has, to some degree at least, been under-valued. In addition, a perusal of his labours shows how great a contribution to our cultural heritage was made during the first half of the eighteenth century by a master mind in an atmosphere free from the ingredients of excessive specialization, and purely departmental thought. Naturally, an intellectual climate of such a kind would not in itself have produced work of such outstanding character as Berkeley's; but it did enable him to flourish to an extent unlikely to be experienced even a century later. Add to this an innate nobility of outlook, a disdain for jargon and all manner of half-truths (including in particular those of the free-thinkers), and the result is a philosopher in the grand manner. Historically, too, this is significant. Berkeley's philosophy was no mere academic exercise; it was a life to be lived and a torch to be carried, not only among the favoured, but more especially into the company of the obscure and oppressed in his diocese of Cloyne. All this needs to be realized before setting out to bring before our eyes of to-day an image of a 'universal specialist'.

In the sequel, too rigid a distinction between Berkeley's original contributions to knowledge and his empirical activities will be avoided. He combined considerable powers of abstraction with a robust common sense all too seldom displayed in a single individual. It may well be doubted whether he would ever have served his generation so effectively had these gifts been present in less perfect balance.

A beginning may conveniently be made with the *Festschrift* of *The British Journal for the Philosophy of Science*. The contribution which discusses Berkeley's work and its importance for modern psychology naturally is focused upon his "New Theory of Vision" (1709). Here, stress is laid upon the object of consciousness; without such an object, further ratiocination is meaningless. As the author neatly remarks, there is a world of difference between what is perceived *as* red light, and what the physicist *calls* red light. (Incidentally, how much a recognition of this distinction would have reduced the temperature of the Goethe–Newtonian battle.) Again, Berkeley seems to have accepted what psychologists call a mosaic structure of awareness—a concept very close to what is often called 'and-summations'. This conflicts in essentials with the *Gestalt* outlook, according to which an experience is with things as wholes, in such a way that they cannot just be added up with the 'and' acting as a species of polar bond. Yet it would be a mistake to regard the good Bishop as wholly incorrect here, because the integrated whole is itself a sensory experience, and has nothing to do with *a priori* assumptions, still less with metaphysics.

We now come to Berkeley's views upon the subject of optics as he found it. He tackled the question of the inverted image upon the retina. Two modern developments may be noted: one that of Stratton (1897), and the other the unpublished work of Erismann, who has been able to study the vertical and horizontal relations separately. Yet again, there is the little-known research of von Senden (1932), out of which comes problems of great profundity concerning a subject born blind, who, through operation, is later enabled to see. For Berkeley, engrossed as he was in philanthropic adventures, all this would have but confirmed his belief in learning by experience, even if that experience subsumed only a portion of previous elements.

In the next paper, the emphasis is upon the physiological mechanism involved in the perception of distance. Berkeley is seen as the link between Descartes and Helmholtz. It should be remembered, however, that Berkeley never conducted any appreciable amount of experimentation (his relative isolation probably made it impossible); but his grasp of practical science is remarkable. In a number of ways, his thought has influenced later work.

We now approach what is perhaps the most significant effort which Berkeley ever made in the intellectual sphere. This was his criticism of the infinitesimal. The germ of all this may be found in his two notebooks ("Philosophical Commentaries"), a product of early life. In these, though no professional mathematician, he was running true to type in displaying his best talent while still quite youthful. The attack was delayed until 1734, but then it came in "The Analyst: or a discourse addressed to an Infidel Mathematician". In brief, Berkeley asserted that in putting $x + o$ for x in x^n, and then allowing o to vanish at the final stage, is to go back upon the fundamental assumption of the whole process. The hypothesis was that the increments were something, or at least that there was such a thing as an increment; which done, these increments were themselves taken to be nothing, or that they were even denied existence. Of course, it is not in the nature of things that the matter should rest there; Newton's theory, suitably modified, could in fact be properly secured. But Berkeley's criticism has proved correct, and the infinitesimal-concept has gone. Other examples of the use of the method of fluxions—especially the calculation of the sub-tangent—came in for some rather rough handling: as a matter of history, one effect was to expose the imperfect grasp of the infinitesimal calculus possessed by mathematicians at the end of the century. Even Lagrange and L. N. M. Carnot were content to accept a sort of 'compensation of errors', and to leave it at that.

Reasons are adduced, in the next article, for the conviction that Berkeley anticipated much of Ernst Mach's work. Certainly, as the author remarks, there is a good deal of the new look about it. Moreover, the historical aspect is important: it resides in Berkeley's "protest against essentialist explanations in science". Taken alongside his distinction in the field of Christian apologetics, this is not a little remarkable.

From here, in the next paper, we are invited to consider Berkeley's philosophy of motion. Before doing so, or in fact in the course of doing so, some reflexions come to light upon the state of mind experienced by scholars in dealing with Newton's "Principia". In spite of Berkeley's use of the phrase

"Infidel Mathematician", in another connexion Newton was not "faithless". Yet there is no doubt that the mechanistic concept of the universe exerted a certain fascination upon those who regarded it as a vast conglomeration of machine-like units. It was only natural that Berkeley, the devoted ecclesiastic, should look upon Newton with some concern. The eighteenth century could name Berkeley as a typical product, scarcely so Sir Isaac.

In 1718 Halley discovered the discrepancy—in relation to the catalogue of Hipparchus—in the position of Sirius and of two other stars. To deal with the 'ultimate' background involves successive approximation; but Berkeley almost certainly struck at the root of the problem in his insistence that "no *one* star should be regarded as more favoured than any other".

A following note brings to light the development of a 'descriptive' in contradistinction to an 'essentialist' concept in scientific theory, and shows how, in the fourteenth century, it was directed somewhat critically at Aristotelian physics.

Finally, a detailed treatment of Berkeley's "Querist", with its strong resemblance to the thought of the late Lord Keynes, rounds off a most valuable collection of essays. A brief outline of Berkeley's life forms a fitting conclusion.

In conformity with the opinion already expressed that it is well to see Berkeley's contributions as a whole (not only those which may be taken to add to the sum of human knowledge, and with which the special number of *The British Journal for the Philosophy of Science* was concerned), some account may now be offered of his more *ad hoc* inquiries. These are of necessity practical, and illustrate another facet of this complex character. First and foremost is his preoccupation with tar-water, first mentioned on February 8, 1741. The use of this he advocated unceasingly during the great epidemic in the south of Ireland as a remedy for smallpox. The prescription ran, "A heaped spoonful of rosin, powdered fine in a little broth". A year later, we find this concoction, or something very like it, being recommended as a tonic. Apparently Berkeley was content with the results as he observed them, and made no attempt to devise controlled experiments to support his action. Nevertheless, it was all of a piece with his overwhelming sense of solicitude for suffering, and in keeping with his disdain for "faith without works". With good reason has he been called a theological utilitarian.

His correspondence reveals numerous occasions when the temptation must have been tremendous to take sides in the burning questions which tore the Emerald Isle of his day into countless pitiful fragments; yet we read in the foreword to his "Passive Obedience" (1712) a determination "to preserve that cool and impartial temper which becomes every impartial inquirer after truth". Again, in his "Discourse to Magistrates", he maintains that prejudice is not necessarily false: it was the carelessness of free-thinkers to confuse prejudice with error.

All this needs to be supplemented by an appraisal of his efforts *pro bono publico*, for example, the grand scheme to found a university for the education of American Indians. In fact, for this project he obtained a substantial Parliamentary grant, which never came to fruition.

To-day, we have a likeness of Berkeley in the portrait by John Smibert in the National Portrait Gallery, London, reproduced as a frontispiece in the special number of *The British Journal for the Philosophy of Science*. A fairly recent cleaning has revealed the date 1728 in place of 1725. Mrs. W. S. Lewis, of Farmington, Connecticut, noticed not long since that the promontory in the background closely resembles Paradise Rock, Rhode Island, with a gentle slope down to the sea on the near side of the rock. This resemblance can be clearly seen in a snapshot which she took from near Berkeley's Farm and sent to the National Portrait Gallery. For these details I am indebted to the kindness of Mr. C. Kingsley Adams, director of the National Portrait Gallery.

Berkeley moved to Oxford in 1752, by then an exhausted man. His death occurred early in 1753, when, in the seclusion of Christ Church, he was laid to rest.

F. I. G. RAWLINS

THE INTERNATIONAL GEOPHYSICAL YEAR 1957–58

IN 1882–83, many nations joined in a great international scientific enterprise, the International Polar Year, in which the geophysics of the polar regions—mainly the Arctic—was intensively studied, and expeditions set up polar meteorological, magnetic and auroral stations and operated them for twelve or thirteen months. In 1932–33 the jubilee of this First Polar Year was celebrated by a repetition and extension of the enterprise, and ionospheric observations were included in the programme.

On April 3, 1950, Dr. L. V. Berkner, at a small gathering of geophysicists at the then home of Prof. J. A. van Allen, Silver Springs, Maryland, U.S.A., proposed a second repetition after twenty-five instead of fifty years, in view of the rapid advances made since 1933 in scientific, especially ionospheric, techniques. Being favourably regarded, this proposal was formally brought before three international scientific bodies in the summer of 1950—the first to meet was the Mixed Commission on the Ionosphere (MCI), formed by the International Council of Scientific Unions (ICSU) under the sponsorship of the International Union for Scientific Radio (URSI) with the co-operation of the International Astronomical Union (IAU) and the International Union for Geodesy and Geophysics (UGGI). The Mixed Commission on the Ionosphere presented the proposal in some detail to the International Council of Scientific Unions, and recommended the formation of a committee to organize a third polar year in 1957–58. The proposals were later endorsed by the International Union for Scientific Radio and the International Astronomical Union in September 1950, and came before the Bureau of the International Council in January 1951; this commended them to its Executive Board, which met in October 1951 and decided to set up a 'special committee' for the purpose, under the direct auspices of the International Council (not a 'mixed commission' of several unions, sponsored by one of them). The choice of members delegated by the Executive Board to the Bureau was made by the latter at its next meeting in May 1952; four members were appointed, representing the International Astronomical Union, the International Unions for Geodesy and Geophysics and for Scientific Radio, and the International Geographical Union, respectively, with Col. E. Herbays, general secretary of the International Union for Scientific Radio, as convener. At the same time, the nations adhering

to the International Council were invited to form national committees to organize their participation in the new Polar Year; and through the Moscow Academy of Science, the co-operation of the U.S.S.R. was invited.

In the summer of 1952 the International Union of Scientific Radio set up its own committee to organize the ionospheric and radio parts of the enterprise, and the Mixed Commission on the Ionosphere discussed and made further proposals concerning it. By that time the view had developed among the unions concerned that the enterprise should deal as much with tropical and southern non-polar regions as with the Arctic and Antarctic, and this change was recognized by the Executive Board and General Assembly of the International Council of Scientific Unions meeting in October 1952, which decided to change the name to the International Geophysical Year (Année Géophysique Internationale, AGI), and also: (i) to charge the committee with the organization of a series of new determinations of longitude differences, an operation for which the International Union for Geodesy and Geophysics, supported by the International Union for Scientific Radio, had requested the formation of a new mixed commission of the International Council; (ii) to invite the other interested unions, like the International Union for Scientific Radio, to set up their own organizing committees, the Special Committee of the International Council (CSAGI) continuing with its very limited numbers; and (iii) to welcome the collaboration of the World Meteorological Organization (WMO) in the enterprise and to add a representative of that body to the Special Committee of the International Council.

In October 1952, a preliminary meeting of some of the members of the Special Committee of the International Council was held, and it was decided to renew the appeal (through Col. E. Herbays, who was elected provisional secretary) for the formation of national committees for the International Geophysical Year and the preparation of national plans; to hold its first full meeting in June or July 1953; to define the International Geophysical Year as extending from August 1957 to the end of 1958 (seventeen months); to propose to the International Council of Scientific Unions a moderate increase in its own membership, in view of the wide scope of the enterprise; and to seek financial support for the International Council from the United Nations Educational, Scientific and Cultural Organization, to provide for a secretariat for the International Geophysical Year from the beginning of 1955.

In March 1953 the Bureau of the International Council enlarged its Special Committee to include eleven representatives as follows: International Astronomical Union, N. E. Nørlund and M. Nicolet; International Union of Geodesy and Geophysics, J. Coulomb and P. Tardi; International Geographical Union, J. M. Wordie; International Union for Scientific Radio, L. V. Berkner and M. Boella; International Council of Scientific Unions, S. Chapman and E. Herbays; World Meteorological Organization, J. Van Mieghem and a second member to be appointed. The Special Committee of the International Council thus enlarged held its first meeting at Brussels during June 30–July 3, 1953; in place of MM. Nørlund and Tardi, MM. A. Danjon and G. Laclavère attended, and alternate representatives V. Laursen (secretary of the Association for Terrestrial Magnetism and Electricity of the International Union for Geodesy and Geophysics) and W. J. G. Beynon (secretary of the Mixed Commission of the Ionosphere) attended by invitation, making twelve representatives in all. (Later in July, N. E. Nørlund was succeeded on the committee by H. Spencer Jones, and A. Danjou was appointed formally as an alternative representative.)

On the first day (spent in administrative session), S. Chapman and L. V. Berkner were elected president and vice-president respectively, and M. Nicolet was elected general secretary from November 1; the period of appointment as provisional secretary of the original convener, E. Herbays, has now ended, and his valuable work for the International Geophysical Year and excellent arrangements for the meeting were warmly acknowledged. On the remaining three days, the Special Committee of the International Council met in open session with the participation of 'observers' delegated by several of the national committees for the International Geophysical Year, twenty-five people being present in all, drawn from thirteen countries. E. Herbays reported the formation of further union and national committees, from which twenty-six documents had been received, outlining union or national programmes and proposals. To consider these documents, eleven groups (partly overlapping) were formed from all those present, to deal with (i) meteorology, (ii) latitude and longitude determinations, (iii) geomagnetism, (iv) the ionosphere, (v) auroræ and airglow, (vi) solar activity, (vii) cosmic rays, (viii) glaciology, (ix) oceanography, (x) the choice and announcement of world days for specially intensive observation during the International Geophysical Year, and (xi) publication. These groups, in the work of which the help of the 'observers' was most valuable; each prepared a draft report and associated resolutions, and then, where desirable, held joint meetings to revise and complete their reports. With the aid of the Royal Meteorological Institute of Belgium, these reports and resolutions were typed and duplicated for consideration by the meeting as a whole; with some further modifications, the combined report and resolutions were adopted by the Special Committee of the International Council, to be a general preliminary guide to the unions and national committees. The committee, in conclusion, expressed its warm thanks for the hospitality it had received in many ways, from the Royal Belgian Academies (in whose Palace the meetings were held), from the Royal Meteorological Institute and its director, Prof. E. Lahaye, from Prof. J. Tison, and from Prof. V. Brien.

The scope of the International Geophysical Year is too wide to be indicated here even in outline; the Special Committee of the International Council recommended each national committee to take steps to inform the scientific and general public on the purpose of the International Geophysical Year and the plans for the enterprise. Here only a few major items will be mentioned.

The main meteorological problem to be attacked is that of the general circulation (and the associated thermodynamics), particularly above the troposphere; and special efforts are urged, and in part are assured, for the exploration of the atmosphere up to 30 km. height (at least on certain of the World Days), especially along the three meridians 10° E., 140° E. and 70° W.

These meridians were adopted also for special ionospheric and magnetic investigation. The World Days, on the average five per month, are to be fixed partly in advance (three per month) and partly

at short notice according to the existing solar activity and expected degree of magnetic and ionospheric quiet or disturbance; these disturbances are among the major problems to be examined further during the International Geophysical Year. A great improvement in auroral observation is to be aimed at, including aid from air pilots and meteorological officers, and also taking advantage of the new means of detection of daytime auroræ, and of auroræ behind clouds, by radio techniques. The latitude and longitude programme is intended to improve the accuracy of time determination and of star catalogues, and to extend our knowledge of the irregularities in the earth's rotation, of the relative displacements on the earth's surface and displacements of the vertical, and of the time of propagation of radio waves. Limited programmes on glaciology, climatology, oceanography and cosmic rays are also envisaged.

The Executive Board of the International Council of Scientific Unions, meeting in Strasbourg shortly after its special committee met in Brussels, provided funds for the secretariat of the Special Committee up to December 31, 1954, and enrolled it for the time being among its 'permanent services'. The International Union of Pure and Applied Physics (IUPAP), through its representatives, expressed an interest in the International Geophysical Year, particularly in regard to cosmic rays, and it seems not unlikely that it will become a participating union, form a union International Geophysical Year committee, and nominate a representative on the Special Committee of the International Council.

By slow stages the Special Committee of the International Council has been constituted, and with the aid of the national committees for the International Geophysical Year set up at its invitation it has formulated an extensive co-ordinated programme the realization of which in large part may now confidently be expected. But the enterprise will not be fully successful unless all the major nations of scientific culture participate in it; for this reason, at the request of its Special Committee, the International Council of Scientific Unions has formally invited the renewal in this enterprise of the valuable and effective co-operation given by Russia to the first and second International Polar Years; and also has requested that the U.S.S.R. should co-operate in encouraging other nations to take part that have not yet agreed to do so.

SYDNEY CHAPMAN

PRODUCTION OF ANTIBIOTICS AND THEIR USE IN INDUSTRY

A SYMPOSIUM on "Antibiotics—their Production and Use in Industry" was held by the Society for Applied Bacteriology at Oxford on July 7. The discussion was opened by Dr. A. Hirsch (Unilever, Ltd., Bedford), who pointed out the desirability for the continued study of polypeptide antibiotics. At the present time these antibiotics cannot be fully utilized because the necessary chemical knowledge and methods for their development appear to be lacking. In this respect, the peptide antibiotics resemble penicillin and other early antibiotics which were developed long after their first description. Most of the successful methods of protein chemistry concern compounds with a molecular weight of more than ten thousand, while paper-chromatographic methods are useful with compounds of a molecular weight of up to a thousand. The intervening gap is not adequately covered, and even counter-current studies are only of limited value because they rely on the hydrolysis of the very structures which ought to be the object of the study.

The rapidly bactericidal nature of the polypeptide antibiotics renders it unlikely that they act by competing with essential metabolites. Surface activity and consequent absorption of the antibiotics on the bacterial surface have been shown to occur in many cases, and the similarity to the antibacterial action of cationic detergents is very marked. This surface activity may not be the immediate cause of the death of the bacterial cell, but at least it enables the antibiotic to be effective in very minute amounts. Surface activity may also eventually permit of more specific action with smaller toxicity than would be possible with metabolic competitors. It was thought at one time that antibiotics effective against Gram-negative organisms would also be toxic, the structure of Gram-negative cells resembling animal tissues more closely than Gram-positive organisms. The polymyxin antibiotics are, however, selective against Gram-negative organisms, and their toxicity is no greater than that of some other polypeptide antibiotics.

The next speaker was Dr. T. S. Work (National Institute for Medical Research, Mill Hill). He discussed, from the point of view of the comparative biochemist, the reason for the selective action of the medicinally useful antibiotics. Penicillin is about ten thousand times more toxic to some micro-organisms than to animal tissues, and even chloromycetin is some hundreds of times more toxic to bacteria than tissues. The available evidence suggests that penicillin at any rate disrupts the protein metabolism of micro-organisms. This may explain the selective action of penicillin, because proteins are well known from immunological work to be the agents responsible for specificity. The study of the synthesis of protein may therefore give a clue to the selective action of the non-toxic antibiotics.

The synthesis of proteins is currently explained in two different ways. They may be built up, piece by piece, from amino-acids, or they may be formed as on a template, the whole molecule being 'stamped out' in a single operation. The latter explanation is largely favoured by geneticists, who regard the genes as the templates. Should this latter explanation be correct, this process might be difficult to investigate experimentally, and the first explanation offers the best hope to break the process down into small steps capable of study.

The nature of protein synthesis has been investigated in lactating animals injected with radioactive amino-acids. The amino-acids passed rapidly through the mammary barrier and were synthesized in the gland to casein and β-lactoglobulin. Immune globulin, however, was found to pass between the milk and the blood stream and was not synthesized in the mammary gland. After radioactive amino-acids were injected into the blood stream, samples of milk were taken and the casein from it mildly hydrolysed. Twelve separate fractions were collected from a column, and the radioactivity of these was found to be equally distributed. This was strongly suggestive evidence that the synthesis occurred by a template mechanism, since an unequal distribution of radioactivity would be anticipated if the protein was synthesized partly from pre-formed peptides and partly from individual amino-acids.

The industrial fermentation of the commercially prepared antibiotics was discussed by Dr. M. Lumb (Boots Ltd., Nottingham). Many of the antibiotics first described in the United States are now produced in Britain; this has not, however, detracted from the value of penicillin, the production of which is still increasing. The largest manufacturer of penicillin is still the United States with 20 million mega-units/month, followed by the United Kingdom with 4·5 million mega-units/month and Japan with 1·5 million mega-units/month. The expense of penicillin production has decreased in recent years for several reasons. Media now contain the correct precursors (for example, phenyl-acetic acid for penicillin *G*), although it remains true to say that corn-steep liquor is still one of the main ingredients for penicillin production. With the streptomyces antibiotics this substance is not quite so useful, and media still need supplementation with expensive meat extracts. The selection of the best strains of moulds and the addition of fatty acids to the medium are other factors which have increased the yields of penicillin. The parent culture for most of the strains in use to-day is strain 48–701; but this has been adapted to local conditions by different manufacturers. The expensive finishing process of freeze-drying of the early days has also been replaced by cheaper and better methods of crystallization.

The place of the assayist in the production of antibiotics was described by Mr. K. A. Lees (Glaxo, Sefton Park). For routine use with penicillin, dihydrostreptomycin and streptomycin, he advocated agar-diffusion assays with *Bacillus subtilis* as the test-organism and phosphate buffer as the diluent. For most routine assays an error of ± 5 per cent is suitable; with increased replication, this can be improved to ± 1 per cent, which may be necessary when preparing fresh standards. A particular problem of antibiotic standardization is that of the relative potencies of the streptomycin and dihydrostreptomycin national standards. For example, does 1,000 units of the streptomycin standard when hydrogenated with 100 per cent efficiency yield 1,000 units of dihydrostreptomycin? This problem of the relationship between these two biological standards appears to be unique, and it may warrant the publication of comparative results on the two standards obtained by several independent physico-chemical and biological methods to enable a reasonable estimate of the relationship between the existing standards to be established.

The use of antibiotics for the control of plant diseases was discussed by Dr. P. W. Brian (I.C.I., Welwyn). The antibiotics developed for medicinal purposes, that is, those commercially available, have not proved very satisfactory for plants, and expense, too, has so far been against this application of antibiotics. Further, these antibiotics are more effective against bacterial than fungal diseases, although the latter are economically the more important. However, the fact that antibiotics, unlike other chemical means of control, can be non-toxic to plants and effective in small concentrations has encouraged the continuance of this research along its own lines.

Recent trends have led to the isolation of antibiotics specifically designed against plant pathogens. Antibiotics such as antimycin, hellixin and toximycin are all effective against experimental apple scab disease and against the development of early blight in tomatoes. Griseofluvin is one of the earlier antibiotics recognized for its antifungal properties and is sometimes known as the curling factor. It is relatively not phytotoxic and can be taken up by a number of plants into their tissues; this may give the plants resistance to some diseases. Under some conditions which may prevail in soils, griseofluvin can be stable, and if the producer moulds were present the antibiotic could be formed in the soil. This offers an attractive way of utilizing antibiotics produced *in situ* for the control of plant diseases.

The well-known effect of antibiotics in animal nutrition was described by Dr. J. W. G. Porter (National Institute for Research in Dairying, Shinfield). There is no longer any doubt that penicillin and aureomycin, and to a smaller extent some of the other antibiotics, cause a significant improvement in the growth-rate of some animals. Thus the growth-stimulating effect of antibiotics is estimated at 12 per cent in pigs, 15 per cent in chicks, 30 per cent in turkeys and 20 per cent in calves. The factors affecting the response are mainly the age of the animal, the response being most marked with young and rapidly developing animals, and the composition of the diet, the effect being most noticeable with all-vegetable diets.

The explanation of this phenomenon is still obscure. The bacteriological picture is confused, and, in chickens at least, the workers at Shinfield have not been able to demonstrate a change in bacterial flora as the result of antibiotic feeding. Even so, the evidence remains fairly strongly in favour of the antibiotic combating a sub-clinical form of disease, because the growth-stimulating effect of the antibiotics disappears if chickens are either raised in new premises or are kept under conditions which strictly exclude micro-organisms.

NEW FISH CULTURE METHODS FOR *TILAPIA* IN EAST AFRICA

By J. M. BROWN
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AND
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VARIOUS species of *Tilapia* are now widely used in African and other tropical countries for fish-farming purposes, their use having been popularized particularly by the intensive work on them in the Belgian Congo.

In many instances, the weight yields from cultivated ponds have been a ton or more per acre per year, figures which are greatly in excess of those obtained in Europe using carp or other temperate region species. In nearly all cases, however, these high weight-yields have been composed largely of thousands of small 'trash' fish—fry and fingerlings which have resulted from unrestricted breeding in the production ponds, with consequent runting of the population.

While it is true that such small fish may be utilized by some African tribes as food, there is no doubt that East African natives, and certainly all Europeans, prefer their fish to be of larger edible size. Early and frequent breeding under tropical pond conditions is indeed the greatest disadvantage of the various *Tilapia* species; and with the various culture methods introduced by Belgian and other workers, it is impossible to ensure that all the fish

are of large size when the crop is to be taken at weekly or more frequent intervals, and not by periodic long-term draining of the ponds. The *méthode mixte*, developed by the Belgians, for example, is an effort to overcome this disadvantage, but in itself suffers from other disadvantages in that it is not possible to take a regular crop of fish over a long period of time, and the final draining during which the fish are sorted involves a definite loss of fertility each time the pond is drained; while the smaller fish which are returned to constitute the next stocking are quite uncertain as regards numbers, and already themselves stunted in growth. Other methods which involve the draining of production ponds before breeding has commenced again result in loss of fertility and impossibility of frequent cropping, while the use of predators is still uncertain.

The crux of the matter is always the too frequent breeding of *Tilapia* in ponds, and the necessity for adapting cultural methods to obviate this; as one delegate to the recent Inter-African Symposium on Hydrobiology and Inland Fisheries put it, what is really required in Africa is a method of fish farming whereby "the farmer manages the fish, and not the fish manage the farmer!"

The only practicable method of controlling *Tilapia* breeding would appear to be one by which the sexes can be separated quite surely in the production ponds. With the species commonly used, it is not generally possible to distinguish the sexes in a mixed population of various ages, unless they are fully mature and the males in breeding coloration with other secondary sexual characteristics developed. By this age, the fish have normally bred once or more, and growth has been checked with the onset of maturation. What is required, therefore, is a certain method of sex separation before maturity, and this we believe we have found during the course of experiments at the Fish Culture Farm of the Kenya Game Department at Sagana.

Work here has been concentrated mainly on the indigenous East African species *T. nigra*, which has already been introduced widely into dams in the past, and shows all the usual features of frequent breeding and over-population. This species is, however, one of the genus group in which the males tend to be larger than the females, and we have found that this sexual size-difference is evident several months before maturity, and that it can be used with complete accuracy for separating the sexes before maturity, providing one starts with a batch of fingerlings of known and similar age. It is not possible to separate the sexes by size in a mixed population of various ages. Furthermore, the degree of difference is apparent early and well marked. With high rates of population it is less obvious; a rate of 1,200 fish per acre gives the best result, but even at 2,400 per acre the difference is still practicable.

The technique is simple. Isolated pairs of fish are allowed to produce batches of fry in spawning ponds. When about 5 cm. long (two to three months), batches of fry of similar age are stocked in fingerling ponds at 1,200 per acre. About two to three months later, at an average length of about 10 cm., sexual distinction in length is obvious and of the order of about 2 cm. At this age, a hundred fish are seined, measured to the nearest 0·5 cm., and the length-frequency of the sample calculated. The figures show two clear peaks, those of the larger size being the males; a dividing size-limit is fixed, allowing 0·5 cm. in favour of males (though there is usually little overlap), and all the remainder of fish above this size-limit are separated out. These are all males and are stocked by themselves in the production ponds. Since sex ratios are nearly always even, at least half the fingerlings each time are males. It is, of course, also possible to utilize the females only, but their growth-rate is not as good as in the males.

Such males in production ponds may reach a commercial size of 20 cm. in about eight to nine months from birth; but as before it is advantageous to keep the 'male only' stocking rate at 2,400 per acre or lower. The natural yield of our Sagana ponds, without fertilizing or artificial feeding, is about 250–300 lb. per acre, and this could presumably be increased by the usual cultural methods.

This method, which we term 'monosex' culture, has a good many advantages. It is not necessary to drain the pond to take a crop; thus loss of fertility is avoided. The crop is taken by seining as often as desired, and from time to time the production ponds are recharged with further males in numbers equivalent to the crop taken. Since breeding is completely eliminated, there is no over-population or runting, and the stock-rate can be kept constant. This method is not a sterilization technique, and some of the separated males do in fact mature; but the check in growth is not so marked. We have also found that if mature males the growth of which has already slowed down are also stocked separately at a lower rate in a monosex pond, their growth-rate can be further increased.

This technique has been applied only to *T. nigra*. We have also experimented with *T. melanopleura* introduced from the Belgian Congo; but although the Belgians have shown that sex differentiation in size occurs with this species after about 20 cm., we have found no evidence of this up to 12 cm., at which size they mature in Kenya. Unless the difference is evident before maturity, the technique is not of great value. *T. melanopleura* has not been satisfactory as a farm fish in Kenya, as the death-rate on handling is far higher than with *T. nigra*, and breeding is irregular, with fewer fry per brood.

The second promising technique which we have developed is based on observations of the feeding habits of *T. nigra*. This species is not a plankton feeder but a grazer, utilizing the epiphytic and epilithic algæ in its environment. Although it is known that the Lake Victoria cichlids apparently utilize only the diatoms in their food, *T. nigra* can thrive well on other green algæ such as euglenids, and diatoms only are not essential.

The soft flocculent mud bottom of the normal fish pond is far from ideal for the growth of sessile algæ, since they require a fairly firm substrate upon which to grow—such as the stonework on the inlet and outlet towers or fringing grass, where indeed *T. nigra* may be seen feeding most. We have therefore tried increasing the hard surface available for algæ by suspending screens of papyrus matting vertically in the water (in an east–west direction, so that both sides receive sunlight at this latitude). Results to date show that fish in such 'screened' ponds show a 15–20 per cent increase in growth over similar fish in unscreened ponds. Thus this technique offers a distinct advance in utilizing the full productivity of the pond. The screens develop a good growth of algæ and protozoa in a few weeks, and fish may be seen grazing along them.

Withy hurdles are now proving more lasting and better, and various other possibilities also suggest

themselves, such as applying fertilizer purely locally to the screen itself, and not to the pond as a whole, since free plankton is of little use to this species. The main essential is to increase the hard grazing area without diminishing the volume of water appreciably, and trials are now also being made of planting the pond bottom with a mat of controllable vegetation to increase the available area for epiphytic algæ.

However, simple screening can be carried out easily and cheaply in African fish-ponds, and screens are easily removed to seine the crop. Screening combined with monosex culture (where we shall supply the males) should solve a good many of the local African fish production problems, where shortage of water and natural disinclination for work precludes any of the more complex procedures such as fertilizing, daily feeding or regular cropping to keep up growth.

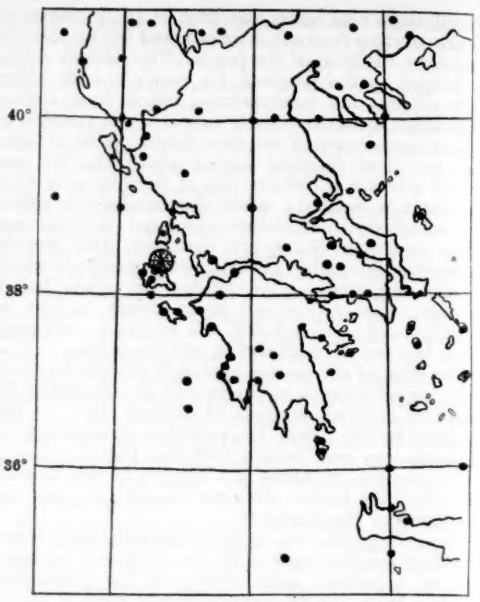
We are indebted to Mr. Hugh Copley, fish warden, Kenya Colony, for constant encouragement and advice, and for permission to publish this preliminary communication.

EARTHQUAKE SWARM IN THE IONIAN SEA

AN earthquake swarm in the Ionian Sea began on August 9, and on August 15 the swarm appeared to be continuing. The epicentres seem to have migrated slightly, but all have been near the Greek islands of Ithaca, Cephalonia and Zante. The earthquakes have not all been of equal magnitude.

The first shock, on Sunday, August 9, at 07h. 41m. 02s. G.M.T., had its epicentre near lat. 38° 19′ N., long. 20° 39′ E. near the islands of Ithaca and Cephalonia. During this earthquake, two hundred houses were destroyed or damaged on the island of Ithaca, three people being killed and fifty injured. The earthquake was registered at Edinburgh with the first pulse *eP* at 07h. 46m. 26s. G.M.T. On Monday, August 10, the shocks continued on the islands of Ithaca and Cephalonia and were strong on the island of Zante. On Tuesday, August 11, an earthquake was registered at the Royal Observatory, Edinburgh, with the first wave *P* at 03h. 37m. 41s. G.M.T. It had its epicentre near the island of Cephalonia at 03h. 32m. 17s. G.M.T. Two villages on Cephalonia, Sami and Aghia Efthimia, were completely destroyed by the earthquake, a hundred and fifty bodies being recovered later from the ruins of the houses and two hundred and fifty people were injured. On the island of Ithaca, the port of Vathy, legendary home of Odysseus, was shaken by the earthquake and also swept by a tsunami or seismic sea wave caused by submarine geological faulting. In Vathy, 98 per cent of the houses were damaged or destroyed. On this day also most casualties occurred on the island of Zante, which had a population of 11,000. The town of Zante was destroyed, three quarters of it being burned by fires occasioned by the scattering of household fires during the earthquake, the water supply having been disrupted. Some three thousand people on Zante Island were rendered homeless.

On Wednesday, August 12, the largest earthquake of the present series as yet was registered at Edinburgh (*P* at 09h. 29m. 12s. G.M.T.). The epicentre was near those of the previous three days and the shock originated at about 09h. 23m. 48s. G.M.T. On this occasion the ports of Argostoli and Lixouri on the island of Cephalonia were completely destroyed. At Argostoli, the former British naval base, with a population of 8,300, the prison, along with all other buildings, was reported to have collapsed, the prisoners being marched to the town square under armed escort. The British destroyer *Daring* reported "as we approached we could feel the ship shaking as if distant depth charges were being dropped". Two hundred and fifty casualties were evacuated and seventy casualties remained to be evacuated.



Greece and Ionian Sea showing previous epicentres (●), and epicentres of August 9 (⊗)

From the coast of Ithaca high columns of smoke arose, and portions of the islands slid into the sea. The Greek Minister, Mr. Adamopoulos, stated that the disaster was greater than that due to the earthquake of April 22, 1928, when part of Corinth was destroyed. The total population of the islands of Cephalonia, Ithaca and Zante was 120,000, and it is estimated that in the present, possibly continuing, swarm there have up to the present time been about a hundred and twenty earthquakes and tremors, some hundreds of people have been killed, thousands injured, 75,000 rendered homeless, and that the material losses have been near £2½ million.

The Alpine folds trend north-north-west to south-south-east through Greece, swing east to west through Crete and continue through southern Turkey in Asia Minor. The zone is one of instability, and gravity anomalies exist. On August 11, 1903, an earthquake occurred in southern Greece with instrumental magnitude 8, and the positions of some recent epicentres are shown on the accompanying map. Earthquakes have occurred previously with approximately the same epicentral position as the present swarm. During the year 1896, the island of Zante was shaken by 306 earthquakes and tremors. From a focus with epicentre at lat. 38° N., long. 20½° E., earthquakes occurred on January 24, 1912 ($M = 6\frac{3}{4}$),

March 9, 1932, and September 20, 1939 ($M = 6\frac{1}{4}$). From a focus with epicentre at lat. 38° N., long. 20° E., an earthquake occurred on February 14, 1943, and from a focus with epicentre at lat. 38½° N., long. 20½° E. an earthquake occurred on January 7, 1943 ($M = 5\frac{1}{4}$); the last-named had a depth of focus of 100 km., the others being from somewhat more shallow foci. ERNEST TILLOTSON

OBITUARY

Prof. R. von Mises

PROF. VON MISES, who died on July 14, had a world-wide reputation among applied mathematicians and aerodynamicists. He was born in Austria on April 19, 1883, and was educated in Vienna, where he obtained his doctorate in 1907. After holding the posts of lecturer, extraordinary professor and professor at Bruenn, Strassburg and Dresden respectively, he was appointed professor of applied mathematics and director of the Institute for Applied Mathematics at the University of Berlin in 1920. He held this post until 1933, when he left Germany to occupy a similar position at Istanbul during 1933–39. He then migrated to Harvard University, where he was first a lecturer and associate professor during 1939–43 and afterwards Gordon MacKay professor of aerodynamics and applied mathematics during 1943–53.

His scientific work covered the whole of mechanics, including elasticity, as well as the theory of probability and statistics, and the philosophy of science. But he will be remembered especially for his researches in theoretical and applied fluid mechanics. To this subject he made numerous contributions, including the theory of aerofoil design and the theory of boundary layer flow.

He had a great influence on the development of mechanics. He inaugurated the famous *ZAMM* (*Zeitschrift für Angewandte Mathematik und Mechanik*) and edited it from 1920 until 1933. In the United States he was editor of "Advances in Applied Mechanics" during 1948–53. His publications number some 142 papers and books on technical hydromechanics, the theory of flight, differential and integral equations of mechanics and physics, the theory of probability, and some writings on positivism.

He had also a great love for literature and possessed a famous collection of books dealing with the writings of Rainer Maria Rilke, to whose work he himself devoted seven articles.

A memorial volume to celebrate his seventieth birthday is in preparation. He leaves a widow, Dr. Hilda von Mises, herself a well-known mathematician. His gracious and lovable personality will be greatly missed. G. TEMPLE

NEWS and VIEWS

Department of Scientific and Industrial Research, New Zealand

MR. L. W. TILLER AND MR. I. D. DICK have been appointed assistant secretaries to the Department of Scientific and Industrial Research, New Zealand. Mr. Tiller will be responsible for the agriculture and biology group of branches of the Department, and Mr. Dick for those of physics and geology.

Mr. L. W. Tiller

MR. L. W. TILLER was born in Nelson and attended Nelson College. He graduated B.Sc. from Victoria University College in 1921, and in 1922 joined the staff of the Cawthron Institute, where he was engaged in agricultural chemistry and fruit nutritional and cold-storage investigations. From there he went to the Appleby Research Orchard of the Department of Scientific and Industrial Research, in charge of more extensive fruit-tree manurial and storage work. In 1936, he was sent to England in charge of the recording of a large experimental consignment of fruit. While in England he studied at East Malling and Long Ashton Research Stations, and at the Cambridge Low Temperature Research Station. On return to New Zealand, Mr. Tiller was appointed fruit research officer of the Department. During the War he and another officer of the Department initiated experiments on vegetable dehydration and later he co-ordinated the work on full-scale commercial production. He also collaborated with the Army and Royal Air Force in producing special combat rations for all three branches of the Armed Services. In 1947 he was appointed director of food and fruit research, one of his activities being collaboration with British research workers in making temperature surveys on new refrigerated ships. Since 1948 he has been deputy assistant secretary (agriculture and biology). In this capacity he has been closely associated with the sections of the Department investigating fruit, tobacco, hop and entomology problems and plant diseases.

Mr. I. D. Dick

MR. I. D. DICK was born at Napier, and graduated in mathematics in 1939. He was appointed a mathematician to the Department to work on problems in mathematical statistics, which were becoming increasingly important in agricultural research. In 1941 he was transferred to the Radio Development Laboratory (established during the War as a separate unit of the Department) to work on the design and development of aerial systems for radar equipment. He left the Laboratory early in 1944 to undertake operational research in Australia as a serving officer in the New Zealand army. In 1945 he went to the Middle East and Italy, serving as a gunner in the artillery. Mr. Dick rejoined the Department in 1946, and was appointed officer in charge of the Biometrics Section. With the extension of mathematical work, this Section became the Applied Mathematics Laboratory in 1949, with Mr. Dick as director.

Technological Education in Great Britain

REPLYING for the Government in an adjournment debate in the House of Commons on July 23, regarding the provision of courses in technology at technical colleges for students living outside the boundary of the local authority maintaining the college, the Parliamentary Secretary to the Ministry of Education, Mr. Kenneth Pickthorn, said that the principle of

regionalism is fully accepted by the Government although it is realized that it may not always be possible to provide in any one college all the courses which students might desire. He thought that there should be little difficulty in making satisfactory arrangements for those students living outside the boundary of the local authority responsible for the college, and he confirmed the Ministry's recognition of the importance of technical and technological development and the vital part which research plays in such development. Nevertheless, it was apparent from Mr. Pickthorn's reply and Mr. William Wells's opening speech that there is little prospect of getting an effective central policy for technical education while it remains under the control of local education authorities, and indeed of the Ministry of Education. The need was again clearly demonstrated for placing the responsibility for higher technological education fairly and squarely on one body closely concerned with university education, such as the University Grants Committee.

Joint Commission on Electron Microscopy

By agreement with the International Council of Scientific Unions, a Joint Commission on Electron Microscopy has been formed, which is made up of four participating International Unions, represented as follows: International Union of Pure and Applied Chemistry, Dr. A. S. McFarlane (Great Britain) and Prof. R. Signer (Switzerland); International Union of Biological Sciences, Prof. L. Bugnard (France), Prof. Irene Manton (Great Britain) and Dr. F. O. Schmitt (United States); International Union of Crystallography, Dr. R. W. G. Wyckoff (United States); International Union of Pure and Applied Physics (the parent Union of the new Commission), Dr. G. Dupouy (France), J. B. le Poole (Netherlands) and Mr. F. W. Cuckow (Great Britain). The Joint Commission is now organizing an international conference on electron microscopy which will be held at the London School of Hygiene and Tropical Medicine during July 6–9, 1954; further details of the conference will be announced later. All communications regarding the Joint Commission should be addressed to Mr. F. W. Cuckow, Provisional Secretary, Joint Commission on Electron Microscopy, Institute of Cancer Research, Royal Cancer Hospital, London, S.W.3.

East African Industrial Research Board: Report for 1952

The tenth annual report of the East African Industrial Research Board covers the year ended December 31, 1952 (pp. 20. Nairobi: East African High Commission, 1953). Full agreement between the East African Governments on the future of research has not yet been reached, and until a permanent organization is established, activities cannot be extended to include civil engineering or metallurgical investigations on the scale desirable. Investigations on hecogenin were concentrated on the pilot-scale production of material containing crude hecogenin from waste obtained in the dry decortication of sisal, and the National Research Development Corporation and the Medical Research Council were supplied with material for use in the synthesis of cortisone. The possibility of separating the niobium mineral pyrochlore from an apatite concentrate obtained from Sukulu soil is being investigated. Triple superphosphate has already been obtained satisfactorily from Sukulu apatite. Investigations of the most economical method of binding fine kyanite for heating in a rotary kiln indicate that pelletizing the powder with molasses gives the best results. A clay deposit has been found near Nairobi from which a satisfactory drain-pipe body can be prepared that will take a lava glaze. Cement clinker giving satisfactory strength tests has been prepared from a mixture of four clays when the interior of a stationary oil-fired kiln was modified so that it was more like a muffle furnace. The study of the fermentation of vegetable matter, such as sisal and papyrus, has been commenced, with the objective of utilizing methane from such fermentation for drying, for the generation of power or as a motor fuel. A full account of preliminary experiments leading to work with a semi-pilot scale digestor on the gaseous fermentation of sisal waste is appended to the report. The gas obtained consists chiefly of carbon dioxide and methane in the ratio 2 : 3 by volume. Other appendixes deal with the purification of diatomite obtained from deposits in Kenya and with methods of improving the setting qualities of plaster of paris obtained by calcining local gypsum.

Max Planck Association for the Advancement of Science

In 1945 the German Research Institute, Berlin-Dahlem, was set up, incorporating the organization formerly known as the Kaiser Wilhelm Institute and Research Establishment. The German Research Institute has now been dissolved, with effect from July 1, and has been joined to the Max Planck Association for the Advancement of Science (headquarters: 10 Bunsenstrasse, Göttingen). The following institutions in Berlin-Dahlem (with number and name of street as shown, followed by the name of the director in brackets) have therefore been taken over by the Max Planck Association: Max Planck Institute for Comparative Genetics and Congenital Pathology, 26–28 Ehrenbergstrasse (Prof. Hans Nachtsheim), and the Department of Tissue Research, 9 Garystrasse (Prof. (Mrs.) Else Knake); Fritz Haber Institute of the Max Planck Association, 4–6 Faradayweg (Prof. Max von Laue); Berlin Department of the Max Planck Institute for Foreign Public Law and International Law, 1 Boltzmannstrasse (Dr. Erich Kraske); Max Planck Institute for Cell Physiology, 32 Garystrasse (Prof. Otto Warburg); Research Establishment for the Recording of Plant Cultures in the Max Planck Association, 16 Faradayweg (Prof. (Mrs.) Elisabeth Schiemann); Research Establishment for Micromorphology in the Max Planck Association, 16 Faradayweg (Dr. J. G. Helmcke).

Stranded Whales and Turtles

The systematic reporting of stranded whales, dolphins and porpoises to the British Museum (Natural History) came into operation in 1913. The keeper of zoology at that time, Sir Sidney F. Harmer, was responsible for starting the scheme, and with the willing co-operation of the Board of Trade and other competent authorities, a valuable supply of material and data has since been sent to the Museum. Up to the present, 1,041 specific identifications of stranded cetaceans have been made. As a result, certain species thought to be rare are found to be commoner than previously believed, and two new species have been added to the British list. Receivers of wreck and the officers of the Coastguard Service have

been mainly responsible for sending in reports and the carcases or the portions of them forwarded to the Museum. The Royal Scottish Museum, the Department of Lands and Fisheries and the National Museum of Ireland, Dublin, and many private individuals interested in marine mammals have also rendered valuable help. As a further aid to all those who are interested, the British Museum (Natural History) has re-issued a pamphlet on the subject (British Museum (Natural History). Guide for the Identification and Reporting of Stranded Whales, Dolphins, Porpoises and Turtles on the British Coasts. By F. C. Fraser and H. W. Parker. Second edition. Pp. viii+42. (London: British Museum (Natural History), 1953.) 2*s*.). The purpose of the pamphlet is to combine in one publication the advice relating to stranded whales, dolphins and turtles issued by the Museum in the past. It is also hoped that the figures and descriptions may help those concerned to distinguish the various species with greater certainty and so add to the interest already demonstrated in this work.

Rats and Mice

In an attempt to reduce the appalling waste of food each year in Great Britain, the Ministry of Agriculture and Fisheries has revised its original bulletin on rats and mice on the farm (Ministry of Agriculture and Fisheries. Bulletin No. 30: Rats and Mice on the Farm. Eighth edition. Pp. iv+17+8 plates. (London: H.M. Stationery Office, 1953.) 2*s*. net). The bulletin is an attempt to explain in simple language the fundamental principles of rodent control, and to provide the farmer with sufficient information to enable him to take effective preventive and control measures. As a means of identification, details are given of the common rat, ship rat and house mouse, while some useful hints are provided on the means of proofing new and old buildings against attacks by these rodents. Means of using poison baits, gases and traps are described, as are the farmer's statutory responsibilities under the Prevention of Damage by Pests Act of 1949.

Milk Pasteurization

A profusely illustrated monograph on milk pasteurization has just been published in the World Health Organization monograph series (World Health Organization. Monograph Series No. 14: Milk Pasteurization, Planning, Plant Operation and Control. By Dr. H. D. Kay, J. R. Cuttell, H. S. Hall, Dr. A. T. R. Mattick and A. Rowlands. Pp. 204. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 10 Swiss francs; 12*s*. 6*d*.; 2.50 dollars). The monograph, which has been published jointly by the Food and Agriculture and the World Health Organizations of the United Nations, has been written by British authorities and contains a digest of the most up-to-date information on the various stages of milk pasteurization, from the planning of a suitable pasteurization plant to the drawing-up of legislation concerning the handling and treatment of milk. The first essential in milk pasteurization is a satisfactorily designed and well-equipped dairy building. The problems involved in determination of the site, choice of processing methods, planning the layout of the building, and selection of construction materials are fully discussed in the monograph, while the three most generally accepted methods of milk pasteurization and the type of plant required for each are described. The operation of the plant is considered in detail, and standards for pre-pasteurization and pasteurization procedures are clearly defined.

Phosphate Absorption and Utilization by Barley

Since the processes of absorption and translocation are closely interrelated in the intact plant, the nutrient content of roots is both determined by the balance of these processes, and is a factor determining their rates. The value of using radioactive tracers in exploring these phenomena is emphasized and exemplified by R. Scott Russell and R. P. Martin in a study of the absorption and utilization of phosphate by young barley plants (*J. Exp. Bot.*, **4**, 10, 108; 1953). Two problems were selected for an initial investigation, namely, the relationship between the external concentration and the rate of absorption of phosphate in actively growing plants; and the relationship between the amount absorbed and the pattern of distribution. The experiments were carried out in water culture with radioactive phosphate supplied over a range of 0·0003–30·0 p.p.m. phosphorus. When the external concentration of phosphate is reduced below 10 p.p.m. phosphorus, the proportion of the absorbed phosphate found in the shoots is markedly reduced. Plants treated with low concentrations of phosphates lose recently absorbed phosphate to the outer medium when transferred to phosphate-free solutions: plants treated with higher concentrations lose a smaller proportion of recently absorbed phosphate. Different balances of other nutrients do not appear to affect the general relationship between the absorption and distribution of phosphate, though quantitative changes occur. The authors conclude that phosphate retention in the roots induced by dilute media is a direct consequence of the small quantity of phosphate entering the roots and is not attributable to the effects of other ions which may be simultaneously absorbed.

Maintenance of Physical Standards

A two-day symposium on "Recent Developments and Techniques in the Maintenance of Standards" was held at the National Physical Laboratory, Teddington, during May 21–22, 1951 (see *Nature*, 168, 594; 1951), and the full proceedings, containing the individual papers presented and the discussions which followed them, have now been published (pp. 100+15 plates. London: H.M.S.O., 1952; 4*s*. 6*d*. net). The contents are divided into six sections dealing with primary load standards, the standard of length, standards of radioactive isotopes, temperature, the standard of light and standards of frequency. Each section consists of two papers, one by a delegate from overseas and the other by a member of the staff of the Laboratory. Research physicists will be interested in the new methods and apparatus proposed or constructed for attaining and improving the extremely high order of accuracy and precision of measurement of the fundamental physical standards; and, in addition, teachers of physics will welcome this up-to-date account of, for example, the light-wave standard of length, or measurements of the velocity of light.

National Museum of Wales: Report for 1951–52

The forty-fifth annual report of the National Museum of Wales, covering the year 1951–52, is as usual an interesting and far from stereotyped docu-

ment (pp. 34+4 pl.; Cardiff: the Museum, 1952). It reveals the many facets of the intense vitality of this Museum, not the least being the large amount of advice on technical matters given by the staff. In geology, advice to various Ministries and other organizations was given on thirty-nine occasions, involving a total of eighty-one hours of work. In botany, 1,078 determinations were made for members of the general public, and 115 inquiries dealt with. The Zoological Department dealt with 370 inquiries, of which 158 were concerned with the identification of specimens and 212 with the preservation of material, economic problems, and advice on students' theses. In the Department of Archæology a total of 457 individual inquiries were dealt with, either verbally or by correspondence. This included 262 inquiries on numismatics, involving 448 identifications. In addition, thirteen special reports were prepared in response to requests for technical information. A total of 493 inquiries were dealt with at the Welsh Folk Museum. This is an impressive record and an indication of the valuable part played by the National Museum in the communal life of the Welsh.

Leeds City Museums

The Committee of the Leeds City Museum has issued a handy guide-book to the collections and their display at the moderate price of 6*d*. A historical introduction concerning the Museum is followed by notes on animal characteristics and by a description of the four bays in the main gallery devoted to the natural history of Yorkshire. The guide-book concludes with references to the cases illustrating the story of man and some special exhibits mainly of local interest. It is well illustrated with photographs and pencil sketches of Yorkshire scenery.

Exhibition of X-ray Crystallographic Equipment

The X-ray Analysis Group of the Institute of Physics will hold its autumn conference in London during November 20–21, and an exhibition of X-ray diffraction equipment will be an important feature of it. Offers of exhibits are invited under two headings: (*a*) apparatus commercially available in Great Britain, and (*b*) examples of recent developments in X-ray crystallographic equipment that have been made in universities and other research centres in Britain. Examples of the kind of exhibit envisaged are: X-ray tubes, diffraction cameras of all types, microbeam techniques, counters and counter-spectrometers for diffraction work, aids to interpretation, monochromators, microdensitometers, travelling microscopes, X-ray films and photographic accessories, and spectrometers for fluorescent analysis. Owing to the limited space available, a selection will have to be made from the offers submitted. Offers of exhibits giving details of approximate bench and floor space required and of any services needed should be submitted before September 1 to the Conference Secretary, Mr. H. J. Goldschmidt, c/o Institute of Physics, 47 Belgrave Square, London, S.W.1.

Institute of Metal Finishing: Officers for 1953–54

The following have been elected officers of the Institute of Metal Finishing for 1953–54: *President*, Dr. J. W. Cuthbertson; *Vice-Presidents*, Dr. S. G. Clarke, Dr. G. E. Gardam, R. A. F. Hammond, Dr. T. P. Hoar, F. Mason, R. W. Nicol, E. A. Ollard and C. Wharrad; *Honorary Secretary*, Dr. S. Wernick; and *Honorary Treasurer*, F. L. James.

Announcements

Emeritus Prof. W. L. Waterhouse has been elected an honorary life member of the Australian Institute of Agricultural Science in recognition of his outstanding contributions to agricultural science in Australia. Prof. Waterhouse recently retired from the position of research professor in the Faculty of Agriculture, University of Sydney.

The Research Fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About £700 a year is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants should be submitted to the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, on the appropriate form not later than November 14.

The Universities Federation for Animal Welfare is holding a summer school during September 19–26 at Westham House, Barford, Warwick. The school will consist of a number of lectures on various aspects of animal welfare, together with films, excursions, etc.; at the same time the Veterinary Section of the Federation will be holding its annual general meeting. The fee for the course is 5 guineas (3 guineas for students). Further details can be obtained from any branch secretary of the Federation or from Miss M. P. Williams, Branch Organizer, UFAW, 7 Red Lion Square, London, W.C.1.

The Atomic Energy Research Establishment, Harwell, is organizing the seventh of its specialized courses on the design, use and maintenance of electronic instruments used in nuclear physics, radiochemistry and work with radioisotopes, all the subjects dealt with being entirely unclassified. The course will be held during September 28–October 2 at the Isotope School (which is outside the security fence), and applications are invited from physicists and electronic engineers holding a degree or equivalent qualification. The course is limited to twelve persons and costs 12 guineas; board and lodging can be provided at a charge of 7 guineas. Application forms (to be completed by September 11) and further information can be obtained from the Electronics Division, A.E.R.E., Harwell, near Didcot, Berks.

The Institute of Personnel Management, in collaboration with the Personnel Management Branch of the Ministry of Labour, is organizing a five-day residential study-course on "Employment and Welfare", to be held at the Coburg Court Hotel, Bayswater Road, London, W.2, during September 6–11. The course, which is limited to twenty persons, is designed for personnel officers and others who are responsible for such matters as recruitment, selection, personnel records and welfare services. The fees are 10 guineas for the course (9 guineas to members of the Institute) and £8 15*s*. for board and lodging. Registration forms, to be completed as soon as possible, and further information can be obtained from the Courses Secretary, Institute of Personnel Management, Management House, 8 Hill Street, London, W.1.

TECHNICAL PROBLEMS OF THE EXPANSION OF TELEVISION IN BRITAIN

IN October 1952 the Postmaster General set up a Television Advisory Committee, charged primarily with the task of advising on the development of television and sound broadcasting in Great Britain at frequencies greater than 30 Mc./s., and the Committee has now published its first report*. This is an important document, for it lays bare the basic technical difficulties of completing the present single-programme network in Great Britain to cover almost completely the whole of the country and of building up another network (or networks) with allowance in the frequency spectrum for the possible extension of the programmes to colour. These difficulties are not insuperable, but they do present problems the existence of which the non-technical public is possibly unaware, and probably the biggest factor operating against their solution is not the technical one but that of finance. In the present controversy that is brewing in Great Britain on the establishment of commercial radio and television in competition with the present monopoly of the B.B.C., these technical difficulties and their inherent financial consideration should not be overlooked.

Besides television there is the problem of higher-frequency sound broadcasting, such as frequency-modulation transmissions, a development which has not made much progress in Britain (probably owing to the excellence of the present amplitude-modulation system and the efficacy of using medium-waves to cover a relatively small island situated in temperate latitudes); nevertheless, if the present service is to be improved and further programmes developed, the experience of other countries indicates that this is a matter which will have to be taken up, and the Committee specifically states that it will be the subject of a future report.

The nature of television requires high carrier-frequencies, and under international agreement the frequency bands allotted for television (and higher-frequency sound broadcasting) are five in number, as follows: (1) 41–68 Mc./s.; (2) 87·5–100 Mc./s.; (3) 174–216 Mc./s.; (4) 470–585 Mc./s.; and (5) 610–960 Mc./s. Bands 1–3 are generally known as 'very high frequencies' (V.H.F.), and Bands 4–5 as 'ultra high frequencies' (U.H.F.). A Technical Sub-Committee under the chairmanship of Dr. W. G. Radley, engineer-in-chief of the General Post Office, and composed of nine other members drawn from the Post Office, the B.B.C., the radio industry, the Department of Scientific and Industrial Research and the University of London, was set up to consider these bands, and their conclusions form the basis of the present report.

Assuming the continuation of the B.B.C.'s 405-line system, a monochrome television programme requires a channel-width of 5 Mc./s. On this basis, Band 1 is scheduled to be completely used up in supplying the present B.B.C. service to 90–95 per cent of the population of Great Britain (at the time of the report about 78 per cent was covered). Band 2 is too narrow to be of much use for television, and it is proposed that it should be left for the provision of additional sound services.

Band 3 will accommodate eight channels and is very suitable for television. Unfortunately an arrangement has already been made in Great Britain whereby the part of the band between 174 and 210 Mc./s. could be used for private communication and broadcasting services, so that a number of business firms and other organizations are, in fact, using equipment within these frequencies; and further to this, on an international level, a number of radio navigational services have been set up in the other part of the band, between 200 and 216 Mc./s. At the moment the only part of Band 3 that could be immediately used for television are two channels situated in the range 184–195 Mc./s. On the basis of these two channels being used for a second television programme, it would only be possible to set up three or four high-power stations situated in densely inhabited areas, and this would cover not much more than half the total population. The Committee therefore strongly recommends that a third channel be made available in Band 3 (or adjacent to Band 3) so that 70 per cent of the population can be served, and it also emphasizes the eventual necessity of clearing the whole band, though this will cause considerable expense because of the existing equipment already operating on these frequencies.

In Bands 4 and 5 it is recommended that any possible allocation should be done on the basis of every third 5-Mc./s. channel, so as to provide room adjacent to each channel for broadcasting the additional signal information that will be necessary for a programme in colour; in this connexion, the Committee is of the opinion that any extension of a television programme to colour should only be done in such a manner that existing sets can continue to receive the programme in monochrome. The preliminary recommendation for Bands 4 and 5 are that allocations should not go beyond 700 Mc./s., and thus, in all, provision can be made for about fifty stations. The trouble with Bands 4 and 5 compared with Band 3 is that they require a minimum field-strength for reasonable reception of about 3 mV./m. as against 0·3–0·5 mV./m. for the latter, and therefore to cover a given area at the higher frequencies requires relatively many more transmitters. In addition, the receiving equipment will cost more, particularly adaptors for converting the signal to lower frequencies that can be handled by sets working at the existing frequencies; in fact, it can generally be said that a great deal of work remains to be done in the development of cheap mass-produced valves, circuits and aerials for the higher frequencies on the same scale as has already been done for components operating at existing lower frequencies.

The last part of the Committee's report deals with general considerations, some of them rather tentative, of the various claims for frequencies that may be, or have been, made by various interests, and the different ways that these claims can best be met. To complete the report, there are four folding maps of Great Britain, the headings of which indicate the information that they give: the possible use of two channels from Band 3 for television stations; estimated coverage planned by the B.B.C. for their first television programme; estimated coverage planned by the B.B.C. for a second television programme assuming

* General Post Office. First Report of the Television Advisory Committee, 1952. Pp. 14+4 maps. (London: H.M.S.O., 1953.) 1s. 6d. net.

the use of six channels in Band 3; and competitive television—approximate transmitter sites and powers as requested by various applicants for licences.

Some of the detailed matter raised in the last part of the report will obviously cause controversy. For example, there is the question of whether the B.B.C. should be granted its request to set up low-power stations on the two free frequencies in Band 3 so as to complete its present national programme or whether it should be forced to use either Band 1 (if this is technically possible) or Bands 4 and 5. Then, as already mentioned, who is to have these two channels for the high-power transmission of a second programme to cover the densely populated regions of Britain, and should this be immediately supplemented by a third channel? From this, one is led to the problem of freeing completely the whole of Band 3; but if television is going to make considerable headway in Britain, even this is not enough, and serious attention will obviously have to be paid to Bands 4 and 5.

Some persons may feel that the actual developments which have taken place so far are such that all this speculation is rather nebulous and that to introduce at this juncture some licensing authority armed with strong powers would be premature because the economic state of Britain in the present conditions of world tension will effectively prevent rapid expansion for many years to come. However, this point of view is refuted by one member of the Committee who, in a minority report, points out that we are already near the point of actually using Band-3 frequencies for a television programme; but because various organizations have been allowed channels on this band for their own private purposes, it is effectively used up, and much money will have to be expended to move them to other frequencies—a financial liability which apparently neither the State nor the organizations concerned are showing much inclination to shoulder.

All this points to the fact that perhaps it would be best in the long run for all concerned if some sort of policy could be formulated now and put in the hands of an effective authority so that the frequency spectrum, which, it seems, is all too small, can be economically shared out in a manner that generally meets with public approval.

AMERICAN PHYSICAL SOCIETY AND THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS

ANNUAL MEETING

THE 1953 annual meeting of the American Physical Society and the twenty-second annual meeting of the American Association of Physics Teachers were held simultaneously at Harvard University, Cambridge, Mass., during January 22–24. In spite of the change of venue from New York City where the past annual meetings had been held, the meetings were well attended with a registration of 1,833 and with more than three hundred ten-minute papers, in addition to longer invited ones, contributed to the various sessions of the two bodies.

At the joint ceremonial session during the afternoon of January 23, the retiring presidential address of the Society was delivered by Prof. J. H. Van Vleck (Harvard University), who took as his subject "Two Barrier Phenomena". In this address he first discussed the barrier which current immigration policies of the United States raises to the entry of visiting foreign scientists, and then described the various theoretical developments which have been required in order to keep pace with the experimental advances in the microwave spectroscopy of ammonia. The Oersted Medal of the Association was presented to Prof. R. M. Sutton (Haverford College), who responded by discussing the heritage of a physics teacher[1], and the eleventh Richtmyer Memorial Lecture was delivered by Prof. E. M. Purcell (Massachusetts Institute of Technology), who took as his subject "Nuclear Magnetism". The after-dinner speaker at the banquet in the evening was Prof. J. A. Stratton (Massachusetts Institute of Technology), who gave an outstanding address on thoughts on technical education stimulated by a visit to Britain, in which he compared education in Great Britain and the United States.

The banquet was also the occasion of the presentation of the first O. E. Buckley Solid-State Physics Prize to Dr. W. Shockley, research physicist at the Bell Telephone Laboratories, for his contributions to semiconductor research. The prize (1,000 dollars), which is administered by a committee of the Physical Society, was established in 1952 under an endowment of a 50,000-dollar trust fund provided by Bell Telephone Laboratories in honour of the Laboratories' former president, O. E. Buckley, who retired recently after thirty-eight years in administrative and scientific posts with the Bell System.

At the business meeting of the Society the following were elected to hold office for 1953: *President*, E. Fermi; *Vice-President*, H. A. Bethe; *Secretary*, K. K. Darrow; and *Treasurer*, G. B. Pegram. A welcome abatement in the rate of expansion of the *Physical Review* was reported by the managing editor, and the treasurer indicated that the present satisfactory position did not call for any further change in the dues and charges.

The twenty-eight invited papers contributed at the scientific sessions of the Physical Society included: a group of three papers by members of the Brookhaven National Laboratory describing new and prospective accelerators at the Laboratory; a separate session in which P. W. Bridgman, G. R. Harrison, G. F. Hull and E. C. Pollard delivered papers dealing with, respectively, recent results at high pressures, échelle spectroscopy, experimental discoveries announced in the programme of the meeting of fifty years ago, and physical studies of viruses; at the symposium of the Division of Electron Physics, individual contributions by M. O'Day (Air Force Cambridge Research Centre) on electron physics in the upper atmosphere, and M. S. Livingston (Massachusetts Institute of Technology and the Brookhaven Laboratory) on the strong-focusing synchrotron; and at the symposium of the Division of Fluid Dynamics, papers on turbulent flow and on phenomena at supersonic speeds. Solid-state physics was represented by contributions by J. A. Hornbeck (Bell Telephone Laboratories) on semiconductors, and P. D. Johnson (General Electric Co.) on luminescence in solids; and in addition to that by F. Bitter on magneto-resonance and magnetic optics, there were several papers dealing with paramagnetic resonance and nuclear resonance. G. Lindström (Nobel Institute of Physics) discussed the establishment of an absolute energy scale in beta-ray spectro-

scopy, and H. V. Neher (California Institute of Technology) spoke about cosmic rays at high altitudes and latitudes. The only contribution on theoretical physics was by J. Schwinger, who dealt with some formal developments in quantum mechanics. The complete list of invited and other papers, together with abstracts, is given in the minutes of the meeting[2].

The programme[3] of the meeting of the American Association of Physics Teachers consisted of thirty-six contributed papers, two invited papers and two round-table discussions on "Physics beyond General Physics for Non-Physics Majors" and "Undergraduate Laboratory Teaching". The former discussion was mainly concerned with physics requirements for engineering students; there was general agreement that instruction in physics should not be transferred from departments of physics to those of engineering, and the question of the use of the 'slug' and the general topic of units was deferred to the next annual meeting. At the business meeting of the Association on January 24, it was agreed to confer honorary membership on R. Pohl, professor of physics in the University of Göttingen, and on J. H. Keenan, professor of mechanical engineering in the Massachusetts Institute of Technology, and to award citations to H. K. Hughes, for his painstaking work as chairman of the Committee of Letter Symbols; E. C. Kemble, as chairman of the Coulomb Law Committee; T. H. Osgood, as editor of the *American Journal of Physics*; R. R. Palmer, as programme chairman of the Association's meetings in 1952 and 1953; K. Lark-Horovitz, for his teaching activities; and to M. W. White, for his successful efforts on behalf of the Association. The following were elected to hold office for 1953: *President*, P. E. Klopsteg; *President-elect*, M. White; *Treasurer*, F. W. Sears; and *Secretary*, R. F. Paton.

[1] Published in *Amer. J. Phys.*, **21**, 369 (1953).
[2] Published in *Phys. Rev.*, **90**, 333 (1953).
[3] Published in full in *Amer. J. Phys.*, **21**, 401 (1953).

OROGRAPHIC CIRRUS CLOUDS

IT has long been recognized that the forced ascent of air over mountains can produce cloud. Only in the past twenty years has it been realized that thin clouds 10,000 ft. or more above the mountains and with no cloud beneath them may owe their existence to the presence of the mountains. Such clouds are not formed by the direct lifting of the lower air up to cloud-level but in the ascending currents of a system of waves which can be produced by the mountain in somewhat the same way that a rock on a river bed produces waves downstream. The wind and temperature structures of the air have to fulfil certain conditions, as Dr. R. S. Scorer, of the Department of Meteorology, Imperial College of Science and Technology, London, has shown. The favourable conditions are an increase with height of both wind-speed and of the temperature lapse-rate. An inversion of temperature in the lower layers of the air followed by a rapid fall of temperature higher up is a favourable arrangement; but a steep fall of temperature with height low down, such as occurs on sunny afternoons, is unfavourable. When the temperature structure is right for waves to form, there must be sufficient water vapour at some height if a cloud is to appear in the ascending currents of the waves at that height.

The Moazagotl clouds which form at 12,000 ft. or more above the Riesengebirge in Germany were found by sailplane pilots to be forming in ascending currents of air and seem to have been the first really high clouds to be recognized as definitely orographic in origin.

Now Mr. F. H. Ludlam, a colleague of Dr. Scorer, claims in the October 1952 issues of *Weather* and the *Quarterly Journal of the Royal Meteorological Society* that some of the cirrus cloud seen over England at heights as great as 20,000 ft. or more is produced in orographic waves. He believes orographic cirrus forms as water particles at a temperature of about − 40° C. The drops soon freeze, and are carried downwind as a trail of ice crystals. Making observations from Dunstable, Bedfordshire, of the azimuth and elevation of the initial points of some cirrus trails and taking the height from the − 40° C.-level in the Meteorological Office upper-air temperature readings, he has been able to relate these initial points to prominent hills such as the Black Mountains, the Long Mynd, Cleeve Hill and the Peak, some of them more than a hundred miles from Dunstable. Sometimes a number of cirrus trails, all at the same height, could be seen streaming each from above the hill responsible for it. A further height check made with good results was a comparison of the movement of details of the trails with the official upper wind observations. In support of his idea he points out that aircraft pilots have observed up and down currents of several metres per second at 10,000–30,000 ft. over the low English hills. Further, the cirrus formation diminishes in the afternoon in accordance with Dr. Scorer's theory of wave formation.

Mr. Ludlam's ingenious and picturesque ideas are not yet accepted by all meteorologists. However, they promise to add a new pleasure to cloud observing—finding the hill over which a cirrus trail begins.

HETEROGENEITY OF DEOXYRIBONUCLEIC ACIDS

By Dr. GEOFFREY L. BROWN and M. WATSON

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THE current belief that deoxyribonucleic acids are intimately concerned in the maintenance and transmission of genetic specificity, for which there is a considerable amount of evidence, leads to the suggestion that preparations of this material may possibly consist of a large number of molecular species differing very slightly from each other in some respect. Chargaff and his collaborators[1] and Wyatt[2] have analysed many deoxyribonucleic preparations with regard to their content of purine and pyrimidine bases, and have found that preparations isolated from the same species have a constant composition, whereas the compositions of preparations from different species vary considerably. There are then three evident ways in which specific differences can be carried by the deoxyribonucleic acid of one species. Either it contains a number of molecules

with different sequences of bases along the polynucleotide chains but all with the same base constitution, or it consists of molecules of different composition with a distribution of base ratios characteristic of the species. The third possibility, that specific folding of the polynucleotide chain may occur, has been ruled out by the X-ray diffraction studies of Wilkins and his collaborators[3] on deoxyribonucleic acids from different species, which show a helical structure independent of the base constitution. Less probable molecular differences that might form the basis of genetic specificity are the length of the polynucleotide chain and degree of polymerization[4]. The object of the work to be described was to devise a chromatographic or similar technique for separating deoxyribonucleic acids from each other using their interaction with histone, a protein with which they are closely associated in cells and with which they might be expected to interact in a specific manner.

Histone, purified from calf thymus according to Daly, Mirsky and Ris[5], was immobilized on the surface of kieselguhr by a method to be described in detail later. The histone-coated kieselguhr stains with acidic dyes and adsorbs deoxyribonucleic acids from 0·1 *M* sodium chloride solutions. The experimental procedure used was as follows. The kieselguhr was dispersed in 0·4 *M* sodium chloride and columns formed in 1·0-cm. diameter tubes; the deoxyribonucleic acid solutions at suitable concentrations were added to the top of the column and washed into the column under pressure, where they were adsorbed. The material could then be eluted by stronger salt solutions, either with stepwise increases in salt concentration or with continuously increasing salt concentrations. 2-ml. fractions were collected on automatic fraction collectors and the deoxyribonucleic acid content of the fractions estimated by their optical density at 260 mμ. A typical stepwise elution diagram of calf thymus deoxyribonucleic acid prepared according to Schwander and Signer[6] is shown in Fig. 1. This shows clearly that with each increase in salt concentration a definite fraction of the deoxyribonucleic acid is eluted sharply at the concentration boundary between one eluting solution and the preceding one, demonstrating that the preparation is heterogeneous with respect to the strength of the salt linkages binding the acid to the basic protein. Fig. 2, curve *b*, shows an elution diagram of the same calf thymus preparation obtained by slowly increasing the concentration of the eluting salt solution to 0·8 *M*. From this it would seem that the preparation is highly polydisperse with regard to these binding properties. Fractionations were also made using larger columns with correspondingly heavier loadings of deoxyribonucleic acid, and the fractions were analysed for their content of purines and pyrimidines by the method of Wyatt[7]. These results are shown in the accompanying table. The analyses demonstrate clearly that the ratios of adenine to guanine and thymine to cytosine of a fraction increase as the salt concentration needed to elute them from the column increases.

Base Analyses* of Fractions obtained from Calf Thymus Deoxyribonucleic Acid

Fraction No.	I	II	III	IV	V	Unfractionated calf thymus DNA
Eluting molarities of sodium chloride	0·4–0·54	0·54–0·61	0·61–0·70	0·70–0·79	0·79–0·9	
Guanine	22·8	19·7	19·5	19·3	16·1	21·5
Adenine	25·8	28·5	29·3	29·8	33·9	28·2
Cytosine	24·0	22·4	19·8	21·3	19·7	21·3
Thymine	27·4	29·4	31·4	29·6	30·3	27·8
Adenine / Guanine	1·13	1·45	1·5	1·54	2·1	1·31
Thymine / Cytosine	1·14	1·31	1·58	1·39	1·54	1·34

* Expressed as percentages of total bases

That the intact structure of the deoxyribonucleic acid is necessary for the binding to histone to be effective and not just a polynucleotide chain is clearly demonstrated by the results shown in Fig. 3. Fig. 3 (*a*) shows that yeast ribonucleic acid is eluted by 0·4 *M* sodium chloride and is not retained by the column as deoxyribonucleic acid. This observation provides a simple and rapid method for the removal of contaminating ribonucleic acid from preparations of deoxyribonucleic acid. Fig. 3 (*b*) shows the complete elution of deoxyribonucleic acid from a column with 0·4 *M* sodium chloride after having been heated at 100° C. for 30 min. in neutral solution. This treatment presumably breaks down the helical structure of the polynucleotide so that the specific binding observed above no longer occurs.

Fig. 2 shows the effect of species difference on the elution diagram of deoxyribonucleic acid. The deoxyribonucleic acid of *E. coli*, type *B*, was prepared according to Gandelman *et al.*[8], except that ribonucleic acid was removed by eluting with 0·4 *M* sodium chloride, as described above, instead of using 'Norit' to adsorb it, and the elution diagram shown in Fig. 2, curve *a*, was obtained. Curve *b* shows a calf thymus deoxyribonucleic acid diagram for comparison and curve *c* an elution diagram of a deoxyribonucleic acid prepared from human white blood

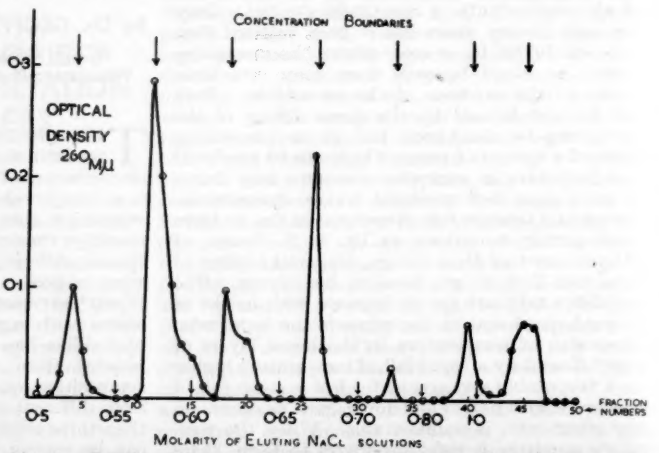

Fig. 1. Stepwise elution of calf-thymus deoxyribonucleic acid from a column of histone-coated kieselguhr with solutions of sodium chloride

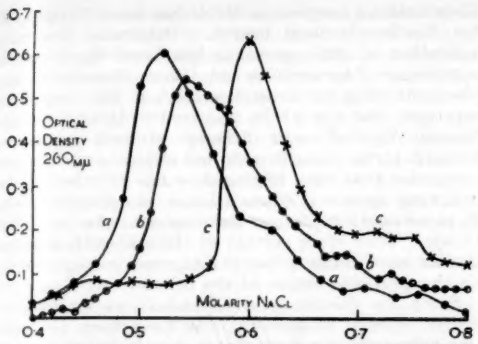

Fig. 2. Elution diagrams of some deoxyribonucleic acids obtained by eluting with continuously increasing salt solutions
Curve *a*, —●—●—●—, deoxyribonucleic acid from *B. coli*, type *B*; curve *b*, —○—○—○—, deoxyribonucleic acid from calf thymus; curve *c*, —×—×—×—, deoxyribonucleic acid from human white blood cells

cells. The ratios of adenine to guanine for these three species have been measured as 1·05, 1·29 and 1·56 and the thymine to cytosine ratios as 0·95, 1·43 and 1·75, respectively[1], and it can be seen from Fig. 2 that the elution peaks are displaced along the salt axis relative to each other in the same order as these ratios. This is further confirmation of the observations made on the calf thymus deoxyribonucleic acid that the ratios of the bases in a fraction vary with the salt concentration needed to dissociate the fraction from the bound histone.

While the work described above was nearing completion, Prof. E. Chargaff and his collaborators generously made available to us their extensive analytical results on extracts of deoxyribonucleic acid from calf thymus nucleohistone using various salt concentrations, which show a similar variation of base ratios with the salt needed to extract the fractions[8]. In our opinion, their results and ours demonstrate that the deoxyribonucleic acid of a particular species consists of a

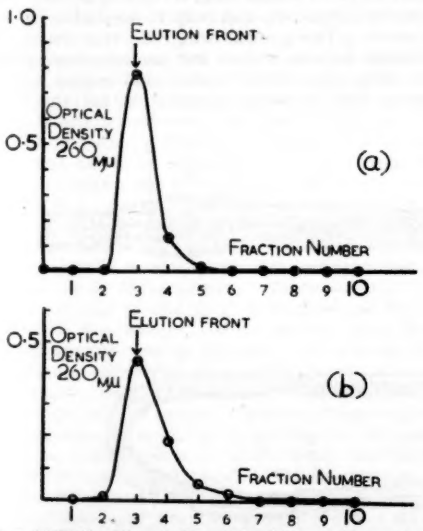

Fig. 3. (*a*) Elution of yeast ribonucleic acid from a histone-coated kieselguhr column with 0·4 *M* sodium chloride. (*b*) Elution of calf thymus deoxyribonucleic acid heated at 100° C. for 30 min. from a histone-coated kieselguhr column with 0·4 *M* sodium chloride

continuous distribution of molecular species with varying ratios of the bases, and that the binding of these molecular species to histone increases as the ratios of adenine to guanine and thymine to cytosine increases. Bendich[16] has observed that deoxyribonucleic acid preparations obtained by extraction of tissues at 85° C. were heterogeneous with respect to solubility in dilute salt solutions and to the metabolism of the purine and pyrimidine bases.

In view of the recent advances in our knowledge about the structure of the deoxyribonucleic acid molecule, it is of interest to consider a possible structural basis for the variation of the strength of the binding to histone, and we wish to put forward tentatively the following explanation. The work of Cavalieri[10] on the spectrophotometric titration of deoxyribonucleic acid with acids and magnesium ions indicates that some of the bases may be bonded to phosphate groups in the molecule. The X-ray diffraction studies of Wilkins, Franklin and their collaborators[11,12] demonstrate that deoxyribonucleic acids have a helical structure with the sugar-phosphate backbone on the outside and the bases pointing inwards. On examination of helical polynucleotide chains, it is evident that with certain types of helical arrangements the 2-amino group of guanine can approach near enough to a phosphate group in the sugar–phosphate backbone to form a hydrogen bond of the type[13] P=O—H—N. The existence of this type of bonding is supported by the infra-red work of Fraser and Fraser[14], who assigned a band in the infra-red to P=O—H. The bonding of an amino group to a phosphate group in this way might be expected to reduce the acidic properties of the phosphate in question, and therefore to reduce the concentration of sodium chloride needed to dissociate the salt linkage that it can form with a basic group in histone.

Therefore, if these ideas are correct, the higher the guanine content of a deoxyribonucleic acid the lower the salt concentration that should be necessary to dissociate it from histone. This is exactly what is found in the experiments described above and by Chargaff and his collaborators in their fractionation experiments. Cavalieri interprets his experiments on the interaction of positively charged dyes with deoxyribonucleic acid[15] as indicating a heterogeneity of binding strengths of the phosphate groups for the dyes which would be expected if the ideas put forward above are correct. Also, his experiments using an equilibrium dialysis technique and spectrophotometric titration show that, first, about 1 mole of magnesium ions per 5 moles phosphorus is bound to calf thymus deoxyribonucleic acid and, secondly, that magnesium probably forms a chelated complex between an amino group and a phosphate group. On the basis of the previous discussion, it seems very likely that again the 2-amino group of guanine is involved, especially as the mole fraction of guanine to total bases is 0·21 in calf thymus deoxyribonucleic acid. We would like to suggest, then, that magnesium and similar ions can form a chelate bridge between the 2-amino group of guanine and a neighbouring phosphate group, the hydrogen bond being broken in the presence of magnesium, thus producing the changes of absorption in the ultra-violet spectrum on addition of this ion, as observed by Cavalieri and verified in this laboratory[15].

All the above evidence for some kind of linkage between the 2-amino group of guanine and a phosphate group in the helical backbone is very circum-

stantial; but the discovery of fractional dissociation of deoxyribonucleic acid observed by Chargaff and his collaborators, and in the experiments described above, and its correlation with guanine content, adds considerable point to that evidence. If further experiments support the idea, it will provide a structural basis for specific interactions between the helical sugar–phosphate backbone of deoxyribonucleic acid and basic proteins which will be determined by the position of guanine in the sequence of purines and pyrimidines.

We are much indebted to Prof. J. T. Randall for his advice and encouragement; to Prof. E. Chargaff for making his results available to us prior to publication and for discussion; to Dr. M. H. F. Wilkins, Dr. W. E. Seeds and Dr. R. H. Smith for useful discussions. We thank also Dr. L. Hamilton and Dr. R. Barclay for a sample of human deoxyribonucleic acid. [July 7.

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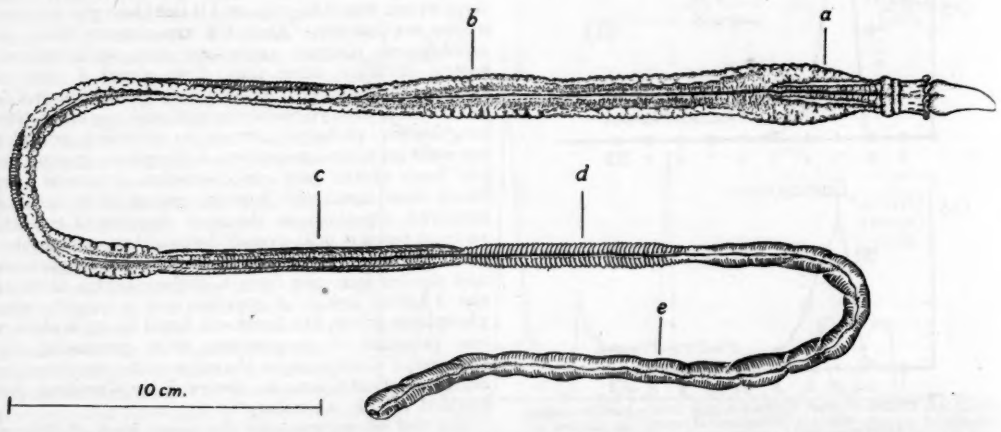
RECORDS OF BRITISH PTYCHODERIDÆ

THE records of the occurrence of the Ptychoderidæ around the coasts of the British Isles are few. A fragment of a *Balanoglossus* has been found on the coast of Galway[1] and an incomplete specimen of *Glossobalanus marginatus* Meek has been dredged off the Northumberland coast[2]. Otherwise the only indication of their presence has been the frequent occurrence of tornaria larvæ[3]. Since these larvæ are planktotrophic for several weeks[4], it has long been supposed that the adults occurred in British waters. Stiasny-Wijnhoff and Stiasny studied numerous tornaria larvæ from British and adjacent waters and concluded that they belonged to one or other of the following species: *Glossobalanus marginatus* Meek, *G. sarniensis* Kœhler, or *Balanoglossus clavigerus* Del Chiaje. They were certain of their identification of the larvæ of *Balanoglossus clavigerus*, but speculated on the probable origin of the others.

Since the discovery of *Glossobalanus marginatus*, several species of Harrimanidæ have been recorded (for references see footnote 5), but hitherto none of the Ptychoderidæ. However, since my work on this group began, numerous specimens of a *Glossobalanus* species have been submitted to me for examination. In all, some forty-four specimens have been collected; of these, five were found in Salcombe Harbour by Dr. D. P. Wilson and students, three were dredged south of the Eddystone Lighthouse by Dr. N. Holme[6] (Plymouth), four at Portaferry, Co. Down, Northern Ireland, by Mr. C. Edwards[7], and the remainder were found by Miss M. Green (Castlecove, Killarney) and the late Dr. Stanley Kemp (Plymouth) in the Kenmare Estuary, Southern Ireland. These specimens were compared with material I collected in the Skagerrak, and with specimens from the British Museum (Natural History). They were all identified as *Glossobalanus sarniensis* Kœhler; but the incompleteness of the existing literature made this difficult, and in consequence a revised description is being prepared for publication.

Previous workers had to rely on incomplete material, so the hepatic region has never been accurately described; yet its form was a deciding factor in the identification of this species. The hepatic sacculæ were dorsally placed in a regular paired series. The number of pairs varied from forty-five to fifty in the specimens examined, and may be exceeded in larger specimens. The genital wings do not overlap the sacculated hepatic region, but are separated from it by a long thin-walled transitional region, and its fragility was probably responsible for the incom-



Glossobalanus sarniensis. A reconstruction based on several specimens. *a*, branchial region; *b*, genital region; *c*, transitional region; *d*, hepatic region; *e*, intestinal region

pleteness of material hitherto described. Most specimens examined were broken at the junction of the genital and transitional regions. The post-hepatic regions were more robust and are well figured by Köehler[8]. The accompanying drawing is a reconstruction based on several specimens showing the hepatic region in its correct form. Sectioned material revealed that the dorsal diverticulum of the buccal cavity had two latero-ventrally placed diverticulæ proximally, the lumina of which remained distinct from that of the main one, but tended to become confluent posteriorly.

All the specimens were found in muddy sand with some admixture of shell gravel. A few of the Kenmare specimens were found in comparatively clean sand and shell gravel. The shores which yielded these specimens were subjected to a good tidal flow without undue turbulence, for in all cases the areas were sheltered from surf action. Adjacent *Zostera* beds or dense algal growth provided an abundance of detritus upon which the enteropneusts could feed[5,9,10].

The associated fauna was in many respects typical of sandy mud, and included *Echino-cardium cordatum* (Pennant), *Acrocnida brachiata* (Montagu), *Leptosynapta inhærens* (O. F. Müller), *Labidoplax digitata* (Montagu), *Upogebia deltaura* (Leach), *Arenicola marina* L., *Amphitrite johnstoni* (Malmgren), *Cerianthus lloydi* (Gosse), *Chætopterus variopedatus* Renier, and numerous bivalves.

The specimens collected on the shore were found between mean low-water springs, and in many instances involved a considerable amount of deep digging. Their burrows often extended from twelve to fifteen inches into the substratum. For an account of the fauna and flora of the Small's Cove and Mill Bay area from which the Salcombe specimens were collected see Wilson[11].

Although many enteropneusts are gregarious animals, and solitary specimens may be strays from a colony near by, the prolonged planktotrophic life of the tornaria undoubtedly results in a wide scattering of individual specimens. *Glossobalanus marginatus* and *G. sarniensis* are both common in the Skagerrak[12], the former favouring muddier areas and deeper water than the latter, and it is very probable that they are also widely distributed throughout the North Sea. The Baltic Stream and cyclic currents of the North Sea would assist in their dispersal. The frequent occurrence of *Tornaria mielcki* and *T. bournei* in this area tends to substantiate this. From collections of adults made in the Skagerrak, and tornaria examined from various parts of the North Sea, it seems that *G. marginatus* is the dominant species, whereas tornaria collected from the Plymouth area and other points in the Celtic Sea indicate that *G. sarniensis* and *Balanoglossus clavigerus* are the dominant species in the English Channel and more southern British waters. Both species have been recorded from the coast of Brittany. Of these species, *Balanoglossus clavigerus* alone penetrates into the Mediterranean Sea, whereas the abundance of *T. bournei* in the waters around the Scilly Isles suggests that *G. sarniensis* is likely to prove the dominant form in the Celtic Sea west of Penzance, and along the Atlantic coast of Ireland. The occurrence of *Tornaria bournei* at Port Erin coupled with the recent Portaferry discovery are strong indications that *G. sarniensis* may also be widely dispersed throughout the Irish Sea.

Thanks are due to all who have provided material or information relevant to the above, and especially to Mr. J. G. Cattley, of the Ministry of Agriculture and Fisheries at Lowestoft, for numerous tornaria, and to Miss M. Green and Dr. D. P. Wilson for much of the adult material.

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Occurrence of the Enteropneust *Glossobalanus sarniensis* Köehler in Northern Ireland

Previous records of adult Ptychoderidæ in British waters are extremely few, despite the widespread occurrence of tornaria larvæ. However, Burdon-Jones[1] reports the occurrence of adults in several localities, and it is of interest to record the recent finding of *Glossobalanus sarniensis* Köehler in Northern Ireland.

Four examples of this species were taken in September and October 1952, at Portaferry, Co. Down, at the narrow entrance to Strangford Lough. They were obtained between the levels of mean and extreme low-water springs in a restricted area of somewhat muddy sand with a substratum of shell gravel. The area is subject to great tidal change of water but with little turbulence, and is adjacent to shores densely covered with weed. These conditions provide an abundance of detritus, as is evidenced by the varied fauna occurring with the enteropneust. Species found commonly or abundantly there include *Cerianthus lloydi* Gosse, *Sagartia elegans* (Dalyell), *Arenicola marina* L., *Amphitrite johnstoni* Malmgren, *Pectinaria belgica* (Pallas), *Ensis arcuatus* (Jeffreys), *Acrocnida brachiata* (Montagu), *Echinocardium cordatum* (Pennant), and *Leptosynapta inhærens* (O. F. Müller).

In view of its restricted intertidal area of occurrence and its sparseness there, it is probable that the main, and so far undetected, area occupied by the enteropneust lies below the tidal zone, and even in the Irish Sea, larvæ being probably brought into the lough with the tidal flow.

Spengel[2] figures the species as having a small egg-shaped proboscis, but admits that he was working with preserved material. Köehler[3] describes the proboscis as being conical in life. My specimens showed it in the resting condition in life to be approximately conical and bluntly pointed.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nidulin and 'Ustin': Two Chlorine-containing Metabolic Products of *Aspergillus nidulans*

A MOULD, isolated by Kurung[1] in 1944 and considered to be a strain of *Aspergillus ustus* (Bain.) Thom and Church, was shown to produce a metabolic liquor which possessed a marked antibiotic activity towards *Mycobacterium tuberculosis* and *M. ranæ*. Afterwards, Hogeboom and Craig[2], by application of a counter-current technique, were able to isolate, from an ethereal extract of this mould and its substrate, two crystalline products, called compound I and compound II, which showed a very high activity against *M. ranæ*. Doering, Dubos, Noyce and Dreyfus[3], using the same strain of mould, isolated a number of chlorine-containing metabolic products, one of which was proved to be identical with Hogeboom and Craig's compound I. Doering *et al.* proposed the name 'ustin' for this compound, established its empirical formula ($C_{19}H_{18}O_6Cl_2$) and published a superficial account of some of its chemical properties.

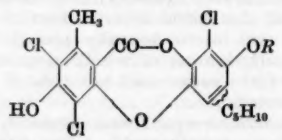
Kurung's original strain has now been examined more exhaustively, and we conclude that it is, in fact, a non-ascosporic strain of *Aspergillus nidulans*.

When this mould is grown at 30° C. on a medium containing Czapek–Dox salts, 4 per cent glucose and 0·1 per cent 'Marmite', some 'ustin' is produced in the substrate and much fatty material is to be found in the mycelium. However, when the mould is grown on the same substrate but at a much lower temperature, the amount of fat is considerably reduced and, from the dried mycelium, a crystalline compound for which we propose the name 'nidulin', can be isolated as the main product. The yield of this compound is very variable, but on one occasion it formed as much as 5 per cent of the dried mycelium.

Crude nidulin is deposited as a brownish crystalline mass when a light petroleum (boiling point 40–60° C.) extract of the dried and powdered mycelium is allowed to stand for six days. (A further quantity is obtainable by extracting the petroleum-extracted mycelium with ether and evaporating the solvent.) The crude product may be purified by successive crystallizations from ethanol (95 per cent) and from light petroleum (boiling point 60–70° C.). Pure nidulin, $C_{20}H_{17}O_6Cl_3$, crystallizes from ethanol in colourless rhombs and from light petroleum in slender, shining rods, melting point 180° C. (Found: C, 54·3; H, 4·0; Cl, 23·7; OMe, 6·9 per cent; equiv., by titration, 435; *M* (Micro-Rast), 463. $C_{19}H_{14}O_4Cl_3(OMe)$ requires C, 54·1; H, 3·9; Cl, 24·0; OMe, 7·0 per cent; *M*, 443·7.) Nidulin is insoluble in water, but soluble in aqueous solutions of sodium hydroxide and of sodium bicarbonate, easily soluble in chloroform, sparingly soluble in ethanol (95 per cent) and benzene and very sparingly soluble in hot light petroleum (boiling point 60–70° C.). A 4 per cent solution in chloroform shows no optical activity.

Nidulin has been shown to be the mono-methyl ether of 'ustin', and the chemistry of these compounds has been investigated in some detail. Since nidulin is, at least under certain specified conditions, the main metabolic product, and since also the mould is now considered to be a strain of *A. nidulans*, we suggest that the name 'ustin' be dropped and that Hogeboom and Craig's compound I or 'ustin' be now called '*nor*-nidulin'.

We suggest the following partial structures for nidulin and for *nor*-nidulin ('ustin'):



Nidulin' (R = CH_3). *Nor*-nidulin or 'ustin' (R = H)

The antibiotic activity of nidulin has been investigated, through the courtesy of Dr. W. F. Short, by Messrs. Boots Pure Drug Co., Nottingham, to whom we are indebted for the following information. Nidulin completely inhibits the growth of *M. tuberculosis* for four weeks at a dilution of between 1 in 5,000 and 1 in 10,000; the test was carried out in presence of serum, by modified Long's medium and the floating-pellicle method. A 0·1 per cent solution also inhibits the growth of the human parasitic fungi *Trichophyton tonsurans* and *Microsporum audouini*, but shows little or no activity towards quite a wide range of other micro-organisms. It is inactive against bacteriophage. (For microbiological testing a solution of nidulin is made by dissolving a known quantity in a little warm ethanol, adding one equivalent of aqueous 0·1 *N* sodium hydroxide solution and diluting with water.)

Full details of the chemistry of nidulin will shortly be published elsewhere.

One of us (J. C. R.) wishes to thank the Leverhulme Trustees for the award of a research fellowship.

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Biogenesis of Alkaloids of Solanaceæ

THIRTY-SIX years ago[1] I directed attention to the structural relations between hygrine, cuskhygrine, tropine and other similar bases, and drew the conclusion that the units concerned in the biogenesis were ornithine or proline on one hand, and an acetone equivalent on the other. P. I. Mortimer[2] now advances a different hypothesis on the sole new ground that hyoscine and nicotine have been found to be congeneric in one instance at least[3].

This latter fact is of great interest; but it is in full accord with my early paper[1]. The matter will be developed from my own point of view in another place.

The arguments from configuration which Mr. Mortimer uses are not significant, because nobody can suppose that the pyrrolidine rings of the alkaloids arise 'directly' from L-proline. There could, and very probably would, be a racemization stage, and the stereoisomeride eventually produced would depend on the exigencies of the situation in the organism. There are several examples of the occurrence of alkaloids, among other natural products, in more than one stereoisomeric form in different plants.

Secondly, the actual mechanism proposed is based on the improbable assumption that the formation of nicotinic acid from tryptophan, admittedly proved in certain cases, indicates the path along which other β-substituted pyridines must have travelled.

It is not even certain that nicotinic acid itself is always produced from tryptophan. The mechanisms proposed by Mr. Mortimer are incomplete and in many places extremely unlikely, as, for example, in the suggestion that 3-hydroxyanthranilic acid might suffer oxidative fission between carbon atoms numbered 1 and 2.

Thirdly, I agree with Mr. Mortimer that the co-occurrences of tropane- and hygrine-type bases are of biogenetic significance, and have been saying this at intervals over a long period of years.

Finally, it is surely a weakness of Mr. Mortimer's hypothesis that, for this base alone, he is prepared to contemplate a reversion to the so-called 'classical scheme'.

There are many other reasons for rejecting Mr. Mortimer's suggestions; but I will only mention their inability to embrace the ring homologous bases (coniine, pelletierines, lobelanine, etc.) in any acceptable manner. These piperidine alkaloids are clearly related to lysine (or piperidine-α-carboxylic acid) in the same way as the pyrrolidine alkaloids are related to ornithine (or proline).

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Dissimilation of Citric Acid by Bacterial Extracts

Aerobacter aerogenes is able to utilize citric acid as sole source of carbon for growth, and from an analysis of fermentation liquors, Deffner and Franke[1] and Brewer and Werkman[2] concluded that citrate is dissimilated to oxaloacetate and acetate as initial products. Dagley and Dawes[3] have confirmed earlier observations on the adaptive nature of the dissimilating enzyme and have shown that cells have maximum activity when harvested from anaerobic media in which citric acid is limiting for growth: media used in the present work fulfil these conditions.

A. aerogenes was grown without aeration at 37° C. in 10-litre flasks filled to the neck with medium of the following composition: 9 gm. trisodium citrate.$2H_2O$; 2 gm. potassium dihydrogen phosphate; 1 gm. ammonium sulphate and 0·4 gm. magnesium sulphate.$7H_2O$ per litre adjusted to *p*H 7·0 with sodium hydroxide. After harvesting, 10 gm. of cell paste was crushed in a Hughes press[4] previously cooled on solid carbon dioxide, taken up in phosphate buffer and, after centrifugation at 7,000 *g*, 60 ml. of translucent cell-free extract was obtained. When 0·5 ml. of extract was incubated at 37° C. with 6 ml. of phosphate buffer (*p*H 7·0, 5 gm./lit. potassium dihydrogen phosphate, 0·4 gm./lit. magnesium sulphate.$7H_2O$) containing 6×10^{-4} *M* citric acid, the latter was completely converted to pyruvate within 10 min. In this period of time the extract showed negligible action on pyruvate; no measurable keto-acid production as determined by the method of Friedemann and Haugen[5] was given from malic, fumaric or succinic acids; but strong oxaloacetic decarboxylase activity was exhibited. Extracts could be stored in the frozen condition and remained active when thawed at intervals for use over a period of at least ten days. Evolution of carbon dioxide measured in a nitrogen atmosphere in the Warburg respirometer was linear in the initial 30 min., and initial rates were directly proportional to the volume of extract present. When the citrate concentration was varied and a fixed quantity of extract used, approximately 1 mol. of pyruvate was produced from each molecule of citrate up to a concentration of the latter of 6×10^{-4} *M*; at higher concentrations the rate of pyruvate production decreased after the initial rapid attainment of a concentration of 6×10^{-4} *M*, and citrate remained in excess even after prolonged incubation. Other instances of the toxic effect of keto-acids accumulating from the action of extracts have been reported[6].

The rate of total keto-acid production, and of pyruvic acid as estimated by the specific toluene extraction method[6], was reduced to one-sixth in the presence of 0·1 *M* sodium fluoride and suggested the participation of magnesium ions as coenzyme in citrate dissimilation in addition to their known role[7] in the enzymatic decarboxylation of oxaloacetate. When extracts were dialysed against water, keto-acid production was stimulated as follows:

	Time of incubation (min.)	Keto-acid produced (μgm./3 ml.) Pyruvate	Total keto-acid
Dialysed extract	20	6·0	8·0
" " + $MgSO_4$	20	24·0	40·0
" "	60	8·0	12·0
" " + $MgSO_4$	60	30·0	30·0

Concentration of $MgSO_4$: $1{\cdot}65 \times 10^{-3}$ *M*.
No keto-acids were produced by extract in absence of citrate, with or without magnesium ions. Additions of manganese did not activate the system.

The nature of the keto-acids produced in the reaction was investigated by paper chromatography of the 2 : 4 dinitrophenylhydrazones by the procedure of Dagley, Fewster and Happold[8]. Production of pyruvate was readily demonstrated but oxaloacetate was not found in most cases; its speed of decomposition by extracts indicated that its accumulation was precluded. When frozen and stored, however, the oxaloacetic decarboxylase activity of extracts diminished. A well-defined spot corresponding to oxaloacetic acid appeared in addition to that for pyruvate when 0·04 *M dl*-malic acid, known to inhibit oxaloacetic decarboxylase[9], was present during incubation of citrate with these 'stored' extracts. These observations accord with the view that the steps in citrate dissimilation are: (1) citrate → oxaloacetate + acetate; (2) oxaloacetate → pyruvate + carbon dioxide. Estimations of acetic acid (by steam distillation) and of carbon dioxide (by respirometry) showed that approximately one molecule of each was formed per

molecule of pyruvate produced, as reactions (1) and (2) require.

Reaction (1) is an apparent reversal of the synthesis of citrate from oxaloacetate and acetate, catalysed by extracts from *Esch. coli*[10]. This view is not supported, however, by our results[3] with whole cells, which indicate that the enzyme involved is adaptive and is suppressed by growth with aeration; extracts from cells so grown possess only feeble activity. Further, when active extracts were treated with 'Dowex-1' according to the method of Chantrenne and Lipmann[11] to remove coenzyme A, additions of the latter and of diphosphopyridine nucleotide had no effect on activity. It appears that citric acid may by synthesized by one biochemical route involving acetyl – coenzyme A and may be dissimilated in certain systems by another.

We express our thanks to Mrs. M. Lees and Mr. J. Smillie for their technical assistance, to Mr. R. Noble for a helpful discussion, to the Agricultural Research Council for grants for these laboratories and to the Carnegie Trust for a personal grant to one of us (E. A. D.) for apparatus.

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A New Hydroxy-acid in the Peel of Apple Fruits

During the examination of paper chromatograms of extracts from whole mature Edward VII apples, a faint acid spot appeared which did not correspond in position with any of the usual fruit acids. On chromatograms of extracts of peel tissue only, the unknown acid appeared to be present in an amount approximately one-quarter that of the malic acid present (the chief acid present in the fruit). About half a gram of the unknown acid was isolated in the pure form from peel tissue extracts by means of silica gel chromatography[1], avoiding contact of the extracts with strongly basic ion-exchange resins during the process[2]. The acid crystallized with difficulty from water as needle-like crystals. Recrystallized from ether it gave a melting point of 94–96° C. On elementary analysis the acid proved to have a molecular formula corresponding to $C_5H_8O_5$ (C = 41·5, H = 5·4 per cent); its silver salt had a silver content of 58·5 per cent. The molecular weight (Rast) was found to be 146. The acid gave on analysis 9 per cent 'OH'; the hydroxyglutaric acids contain 11·5 per cent 'OH', but β-hydroxy-acids tend to lose water when treated with acetic anhydride, which would lead to low results in the determination of 'OH' groups. Solutions of the acid gave a positive Denigès test[3] after oxidation with potassium permanganate. These facts provide the basis for its provisional identification as either β-OH-glutaric acid or citramalic acid. Further details will be published elsewhere.

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Purines in Grassland Herbage

The non-protein nitrogenous fraction of grassland herbage usually represents 15–20 per cent of the total nitrogen of the herbage. Since the fraction is frequently blamed, without supporting evidence, for causing ill-defined disturbances in animal health, it is obviously desirable to learn as much as possible about its constituents.

It is known that ammonia, nitrate, acid amides and amino-acids account for 50–60 per cent of the nitrogen of the fraction and their determination presents no difficulties; but the remainder has not been investigated in detail.

The fraction is receiving attention at Jealott's Hill using methods of paper and ion-exchange chromatography. A purine fraction has been separated which contains a mixture of several purines. Four purines have been identified almost certainly as adenine, guanine, xanthine and hypoxanthine, although the latter is not invariably present.

In most of the work herbage juice has been used, removing chloroplasts, protein, etc., by heat and alcohol treatments. The passage of the clarified juice through Zeo-Karb 215, followed by displacement of the bases by alkali, resulted in material coming out of solution in the column and this upset the regularity of displacement. Tests suggested that the insoluble material consisted of purines, and in subsequent work purines were removed from the clarified juice by precipitation with ammoniacal silver nitrate.

The purine fraction, after precipitation of silver with hydrochloric acid, was examined by paper chromatography. The paper when viewed in ultra-violet light (260 mμ) showed four spots which corresponded with the positions of pure adenine, guanine, xanthine and hypoxanthine. So far, it has not been possible to elute the spots and determine the quantities of the individual purines by ultra-violet absorption since the salts and foreign matter present cause tailing of the spots.

Further purification and separation have been effected by passing the solution of purines, in 2 *N* acid, through a Zeo-Karb 216 column and eluting with 2 *N* acid. Examination by ultra-violet absorption of the fractions collected showed the presence of the four purines; but considerable overlapping occurred. Using the fractions showing greatest absorption, absorption curves and maxima were obtained which correspond closely with those quoted by Cavalieri *et al.*[1] for the purines mentioned above.

If the purines could be eluted separately from an acid resin column, their quantitative determination

would be relatively simple. Several workers[2,3] have attained complete separation of adenine and guanine; but, so far, we have failed to avoid marked overlapping when four purines are present.

The presence of four purines in grassland plants is of interest and, so far as is known, has not been reported previously. It seems likely that they exist in the free state, although enzymic breakdown of nucleosides, etc., during extraction of the plant juice cannot be ruled out.

It might be mentioned that when herbage juice is passed through a Zeo-Karb 215 column at least two substances absorbing ultra-violet light at 260 mμ pass rapidly through. Paper chromatography suggests these include the pyrimidines, thymine and uracil.

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Some Effects of Mosaic Virus on Nitrogen and Phosphorus Metabolism in Tobacco Plants

Experiments to determine the effects of infection with tobacco mosaic virus (Johnson's No. 1) on the nitrogen and phosphorus metabolism of tobacco leaves were made with a hundred plants grown in sand culture. Fifty plants when at the 8-leaf stage were infected artificially with pure virus. Groups of these and of the corresponding control plants were harvested 17, 27 and 40 days after infection.

Analyses of the leaves (from which midribs were excised) revealed that the concentrations of protein nitrogen and protein phosphorus (expressed as gm. per 100 gm. dry matter) were higher in leaves of infected plants than in those of the healthy control plants. The growth-rate of infected plants was lower than that of healthy controls, and this offset the higher concentration of protein nitrogen, with the result that the total protein nitrogen per plant was slightly lower in infected plants.

The concentration of protein phosphorus was higher in infected than in healthy plants throughout the forty-day growing period. In the healthy plants it decreased by 40 per cent during the period of observation, whereas in infected plants it remained constant. The total amount of protein phosphorus increased from 2·6 to 9·3 mgm. per plant in both healthy and infected plants after seventeen days; but thereafter the amount in the healthy plants remained sensibly constant while the total increased to 11 mgm. in the infected plants.

The virus content of homogenates of infected leaves as determined by the primary lesion method, described by Best[1], using a solution of known virus content[2] as reference standard, revealed that the virus formed an increasingly large proportion of the total protein of older leaves as infection proceeded, but constituted a roughly constant proportion of the protein of younger leaves.

The nitrogen–phosphorus ratio of the protein in the healthy leaves fell from 112 to 69 in forty days, whereas that of infected leaves fell to 54. This kind of difference would be expected because the virus nucleoprotein itself has a nitrogen–phosphorus ratio of 32. If we assume that the whole of the difference in the nitrogen–phosphorus ratio between healthy and infected plants is due to the presence of virus in the latter, we can calculate the weight of virus present. Values calculated in this way were in most cases higher than those obtained by the infectivity method. In young leaves only about one-quarter of the calculated 'total virus' was infective. In older mature leaves the proportion of infective virus was higher; but it decreased with duration of infection. The calculated total virus per plant continued to increase linearly with time throughout the growth period, whereas infective virus reached an apparent maximum after twenty-seven days. Our conclusions are consistent with those published by Bawden and Pirie[3].

The difference between amounts of 'total' and infective virus could be explained as being partly due to some infective virus having become inactive (older leaves), and partly to the presence of a non-infective pre-virus stage (young leaves).

All the above relates to plants grown with adequate nutrients. In a parallel series of plants grown under the same conditions but with nitrogen at a level which limited growth, the dry weight after seventeen days was 80 per cent, and after forty days 56 per cent, of that of the plants which had received adequate nitrogen. Although the plants with adequate nitrogen yielded a higher dry weight than the plants receiving inadequate nitrogen by a factor of 1·8, the amount of infective virus per plant was greater by a factor of 12 at the first harvest and 8 at the last harvest. On a concentration basis (gm. virus per 100 gm. dry matter) the factor was 11 and 5 respectively on the whole plant. When top and bottom leaves were analysed separately, the difference between the two nitrogen treatments was much greater in the bottom leaves than in the top leaves, the factors being 19 and 5 respectively. It would appear that when nitrogen is a limiting factor, the production of normal plant proteins is affected less than the production of virus.

A full account of this work will be published elsewhere.

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Conversion of Plant Nitrogen to Microbial Nitrogen in the Rumen of the Sheep

Plant protein in the fodder of ruminants does not arrive unaltered at the abomasum where peptic digestion takes place; there can be no doubt that at least a part of it is degraded, and later resynthesized to microbial protein by the enormous numbers of bacteria and other micro-organisms in the rumen. From time to time attempts have been made, usually on a basis of insufficient data, to calculate the extent of this conversion, and the estimates have varied from almost negligible proportions to 100 per

Table 1. Nitrogen and Lignin in the Fodder and Rumen Contents of a Sheep

		Nitrogen (mgm./100 gm.)			Nitrogen (mgm./gm. lignin) in rumen contents or in fodder†		
		Protein N	NPN*	Total N	Protein N	NPN	Total N
Rumen contents	Plant residues	62	10	72	42	7	49
	Micro-organisms	87	5	92	59	3	62
	Residual liquid	3	25	28	2	17	19
	Total	152	40	192	103	27	130
Fodder (wheaten hay)		870	240	1,110	107	30	137

* Phosphotungstic acid was used to precipitate proteins: boiling water extracts were employed in NPN determinations on fodders and plant residues.
† The fodder contained 8·1 per cent and the rumen contents 1·48 per cent lignin.

cent conversion[1]. Two more recent attempts[2] have involved the feeding of special proteins—zein and casein. No data are as yet available, however, which allow an accurate estimate to be made of the extent to which this conversion takes place in animals fed on natural fodders. In the course of certain studies of the functions of the omasum in the ruminant stomach (to be published elsewhere) we have had occasion to examine the distribution of nitrogen in the rumen contents of slaughtered sheep which had previously been fed on wheaten hay, and some of the results, together with analyses of the fodders, provide interesting information on the quantitative aspect of the conversion of plant to microbial nitrogenous compounds.

In Table 1 analyses of nitrogen and lignin in the fodder and rumen contents of one sheep are given in detail, and Table 2 presents a summary of the findings in seven animals. The solid and liquid portions of the rumen contents were separated by squeezing the material through muslin and washing the residual solids with water. The lignin content of the solids was determined by the method of Norman and Jenkins[3]. The liquid portion was separated into micro-organisms and residual liquid by centrifuging at 15,000 r.p.m. (17,000 *g*) for 30 min. Nitrogen determinations were made by the Kjeldahl method. Since lignin is not digested by sheep[4], the nitrogen concentrations in the fodder and rumen contents have been expressed as mgm. nitrogen/gm. lignin, so that a direct view of the extent of conversion of plant to microbial nitrogen, at the time of slaughtering, is available. Thus, in the example given in Table 1, 48 per cent of the total nitrogen of the rumen contents was present as microbial nitrogen, and (from Table 2) animals slaughtered at 2½, 3, 4, 8 and 16 hr. after the end of the feeding period all indicated that approximately 50 per cent of the nitrogen was microbial nitrogen. Furthermore, the fact that the concentration of total nitrogen, in terms of lignin (mgm. nitrogen/gm. lignin), was at all times nearly the same in the rumen as in the fodder, points to the conclusion that there was no significant overall gain or loss of nitrogen from the rumen other than by passage of the whole contents to lower levels of the alimentary tract. With certain fodders there may be significant losses of nitrogen by absorption of ammonia; but with wheaten hay this is apparently not the case. It may therefore be claimed that, when wheaten hay is fed to sheep, there is a conversion of about half of the plant nitrogen to microbial nitrogen in the rumen.

Table 2. Nitrogen in the Rumen Contents of Slaughtered Sheep Previously Fed on Chaffed Wheaten Hay*

Sheep No.	Time after end of feeding period (hr.)	Nitrogen in rumen contents (mgm. N/gm. lignin in whole contents)				Nitrogen of rumen contents present as microbial nitrogen (per cent)
		Plant residues	Micro-organisms	Residual liquid	Total	
1	2½	49	62	19	130	48
2	3	43	65	17	125	52
3	4	62	78	8	148	53
4	4	62	66	7	136	49
5	4	75	69	8	152	45
6	8	67	85	12	164	52
7	16	51	76	14	141	54

* Fodder contained 1·11 per cent nitrogen and 8·1 per cent lignin-nitrogen = 137 mgm./gm. lignin.

These findings emphasize the important influence exerted by the rumen micro-organisms on the nature of the protein which finally becomes available to the host. They point also to the necessity for similar quantitative studies to be made of the extent to which the proteins in other plant fodders and concentrates are modified in the rumen, and thus to illuminate further the overall nutritional problems implied. Investigation of the amino-acid composition of the microbial protein synthesized in the rumen is undoubtedly of prime importance.

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Effect of Cholinesterase Inhibitors and Atropine on Active Sodium Transport across Frog Skin

Recent experiments have shown that compounds which affect acetylcholine metabolism can modify ion movement in a variety of tissues[1]. The locus of such drug effects can be better defined in the isolated frog skin, where it is possible to study quantitatively the active transport of sodium ions[2].

The anticholinesterase tetraethylpyrophosphate inhibits transport of sodium ions completely when added to the inside of the skin. Fig. 1 shows that there is a transient rise in the net flux of sodium ions (that is, inflow minus outflow) followed by an inhibition which is virtually complete in an hour. Inhibition was usually irreversible, although occasionally there occurred a slow, partial recovery. At the same time the diffusion resistance (electrical D.C. resistance) increased markedly. This seemed to

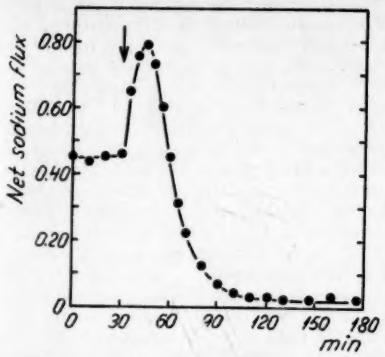

Fig. 1. Effect of tetraethylpyrophosphate on the active transport of sodium ions. The drug was added at the arrow to a concentration of 6×10^{-5} *M*. The net flux is in μM per cm.^{2} of skin per hr.

indicate that the skin was not structurally damaged. Another anticholinesterase, physostigmine (eserine), also inhibited the active transport of sodium ions. In this case, however, inhibition was reversible.

When applied to the outside of the skin, eserine was ineffective in concentrations less than 10^{-3} *M* and only slightly inhibitory at higher concentrations. Tetraethylpyrophosphate, in concentrations greater than 10^{-3} *M*, stopped the net movement of sodium ions; but the diffusion resistance dropped to a value approaching that of Ringer solution, which seemed to show that structural damage ensued.

When the outside of the skin was exposed to atropine, there was a marked increase in transport of sodium ions. Fig. 2 shows the results of an experiment in which atropine was added at the first arrow; when a new steady state was attained, the drug concentration was increased. In general, the flux increased as some non-linear function of the drug concentration, and the effect was sustained as long as the drug remained in the bath. It was reversed on washing with Ringer solution.

These experiments were performed on the skin of *Rana esculenta*. A few measurements with *R. temporaria* showed that the effect of tetraethylpyrophosphate could be repeated; but atropine did not cause stimulation.

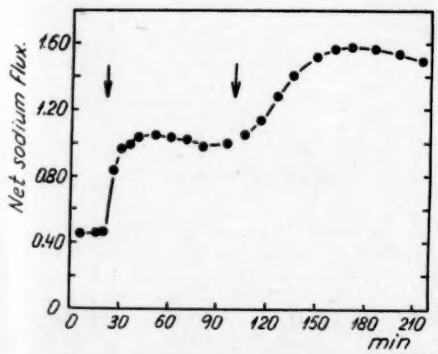

Fig. 2. Effect of atropine on the active transport of sodium ions. Atropine was added at the first arrow to a concentration of $2 \cdot 8 \times 10^{-3}$ *M*; concentration was increased to $1 \cdot 5 \times 10^{-2}$ *M* at the second arrow

The 'atropine effect' can, in fact, be induced by a series of pharmacologically diverse drugs, among them several curares, histamine and pilocarpine. Acetylcholine itself has little effect on the outside of the skin; hence it is very unlikely that the response to atropine involves the well-known competition between these two compounds. The action of the anticholinesterases, on the other hand, seems to parallel their activities as enzyme inhibitors. Three have been tested (tetraethylpyrophosphate, eserine and procaine) and their effects are nearly identical, although they have in common only their anti-esterase activities. The reversibility of the eserine inhibition and the irreversibility of the effect of tetraethylpyrophosphate are parallel to their properties as enzyme inhibitors.

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Secretion of an Orthodiphenol in the Corpus Cardiacum of the Insect

ALTHOUGH it has been known for some years that the corpus cardiacum of insects contains a chromatophorotropic principle active on the chromatophores of many Crustacea[1], there has been very little information on the functions of the gland in the insect itself. It was interesting, therefore, to observe an effect of corpus cardiacum extract on the heart and gut of the insect.

Most of the observations have been made on the cockroach, *Periplaneta americana*. If the heart is prepared as described by Krijgsman and Krijgsman-Berger[2] and perfused with a suitable Ringer solution, it beats steadily for hours. A Ringer solution containing the aqueous extract of one pair of corpora cardiaca of the cockroach in each 10 ml. of solution causes an increase in the frequency of beat of some 50 per cent above normal. The amplitude of beat is also increased. At concentrations one-tenth as great an effect on the frequency cannot be observed; but the amplitude is still affected. These effects continue as long as perfusion with extract goes on, and the heart returns to normal very soon after the extract is replaced by normal Ringer solution.

The gut of the cockroach and of the locust, *Locusta migratoria*, will record peristaltic movements on a kymograph drum for at least twenty-four hours if perfused with the Ringer solution developed by Griffiths and Tauber[3]. An extract of one pair of corpora cardiaca to 10 ml. solution causes the rate of peristalsis in the hind-gut of the locust to be doubled, and stronger solutions have more marked effects. The hind-gut of *Periplaneta* behaves in the same way, but the peristalsis of the foregut seems to be inhibited by extracts of the gland. It is certain, also, in the locust that the increase in peristalsis of the Malpighian tubes observed by Koller[4] is due to a substance from the corpus cardiacum as well as from the brain. Boiling has no effect on the extract.

The corpus cardiacum gives a positive response to Lison's chromaffine test for orthodiphenols[5]. The extraction procedure of von Euler[6] for adrenaline was carried out on *Tenebrio molitor* larvæ, and the extract developed on paper chromatograms with somewhat different results from those of Gregerman and Wald[7]. If the brei is extracted quickly, instead of standing overnight in the refrigerator, a third spot is developed between R_F 0·3 and 0·4. This spot, if eluted, has the activity of corpus cardiacum extract; the other spots have not. A similar spot from a cockroach preparation has been shown to be due to the active substance from the corpus cardiacum. This position does not correspond to that of adrenaline on the paper chromatogram.

Attempts to compare the chromatophorotropic activity of this eluted material with crude corpus cardiacum extract, by injection into the prawn *Leander squilla*, have so far been quite inconclusive.

It is concluded, from the above results, that insects do not secrete adrenaline, but another orthodiphenol having the functions of adrenaline in the insect body.

The nerve connexions of the gland with the brain have been severed and the gland tested for activity after five and seventeen days. No change in activity was detected. It is likely, then, that the material is secreted in the gland itself and not in the neurosecretory cells of the brain[8].

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Action of Gamma-Rays on Seeds of *Cannabis sativa* L.

The differential sensitivity of certain chromosomic zones to ionizing radiations is a problem of theoretical and practical importance. Müller[1] and Kaufmann[2] reported a higher sensitivity to X-rays for heterochromatin *X* of salivary gland chromosomes of *Drosophila melanogaster* than for euchromatin. Such problems are more difficult to investigate in plants. Nevertheless, recent investigations of Camara, Wagner and Gardé[3] on autosomes in *Triticum* indicate the existence of heterochromatic zones of higher susceptibility to X-rays.

The present communication is confined to *Cannabis sativa*, the heterochromosome *X* of which has a definite form and a greater amount of heterochromatin than the autosomes of *Triticum*; normally, it has two arms, one longer than the other, each containing two euchromatic zones separated by a heterochromatic zone. For this reason, *Cannabis sativa* is an adequate material for such investigations.

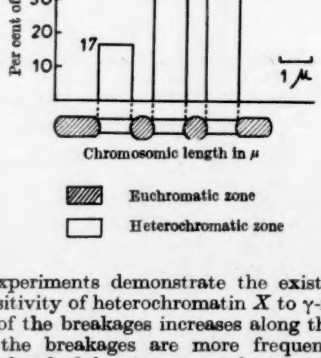
About fifty seeds are arranged on a cylindrical surface of 4 cm. diameter, at a distance of 2 cm. from a radium tube 4·4 mm. high, with a diameter of 7·8 mm. and containing 200 mgm. radium *El*. Seeds are irradiated for 40, 80 and 200 hr., which represents respectively about 16,800, 33,600 and 84,000 r. After washing for half an hour, two to eight days germination and half an hour pre-fixation in a solution of 0·043 per cent oxyquinoleine (evidence of centromeres), the root tips are fixed in acetic-alcohol solution (3–1) and followed by Feulgen squashes.

We observed giant cells which present the following characters: great number of nuclei (20–50), nuclear polymorphism, variability of chromatic bodies, presence or absence of nucleolus, great amount of atypic mitosis with slightly and deeply coloured chromosomes and abnormal chromosome numbers. The plasmodia seemed to be of procambial origin. The number of mitoses was higher in irradiated plants (20–30 per cent) than in non-irradiated plants (1–2 per cent). The cytological abnormalities of heterochromosome *X* were chromosomic bridges, breakages and translocations. Breakages occur most frequently in the *X* heterochromosomes, as indicated in the accompanying table.

Percentage of Observed Cells showing Abnormalities

Autosomic bridges	13·2
Heterochromatic *X* bridges	13·8
Heterochromatic *Y* bridges	7·1
Autosomic breakages	18·0
Heterochromatic *X* breakages	36·5
Heterochromatic *Y* breakages	3·0
Translocations *Y*—*X*	2·0

A distinctive property of heterochromosome *X* consists in an abnormal extraposition during mitotic metaphase, and in many cases we observed this extraposition. Translocations on the terminal euchromatic segment of *X* were also identified. The numbers of heterochromosome *Y* were too small to enable us to discuss its radio-sensitivity. Breakages appeared in different zones of *X*, and they are generally located in the heterochromatin (see graph).



Our experiments demonstrate the existence of a high sensitivity of heterochromatin *X* to γ-rays. The number of the breakages increases along this chromosome: the breakages are more frequent for the neighbourhood of the centromere than for the heterochromatic zone of the longer arm and more frequent also for the heterochromatic zone of the shorter arm than for the centromere. It is possible that this observation could be used in order to control the sexual characters in *Cannabis*.

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Combined Hormone-Fungicide Sprays for Control of *Botrytis* Fruit-Rot in Glasshouse Tomatoes

In recent years, losses in glasshouse tomato crops caused by *Botrytis cinerea* Pers. have become serious in New Zealand. This is particularly true of crops treated with fruit-setting hormones, where the dead petals are retained at the calyx end as the fruit expands. These dried petals provide entry points for infection of the fruits. Heavily sporulating centres of infection thus develop early in the life of the crops, increasing the likelihood of later epiphytotic development of all phases of the disease. This is a frequent occurrence in crops treated with hormones. Some form of protection for these petals is desirable, therefore, to reduce loss of fruit and prevent early build-up of infection.

In the process of fruit-set, different parts of the corolla of the tomato flower are for a period shielded from spray—at first, part of the under petal-surface by the calyx, and later, after wilting occurs, the inner petal-surface. Because a normal fungicidal programme is not related to truss development, it does not provide efficient cover for all petal surfaces. To give the necessary protection, sprays must be applied both before and after fruit-set. The correct time for the earlier of these protective sprays coincides approximately with that for the normal fruit-setting hormone spray, and it seemed likely that a combined hormone-fungicide spray at this stage could be used.

Experiments at this Station have shown that a high degree of protection is obtained by applying a suitable therapeutant with the hormone as a truss spray at full bloom, followed by a further spray of therapeutant alone 10–14 days later. A fungicide for this purpose must be compatible with the hormone and not affect fruit development. Various therapeutants have been submitted to laboratory screening tests and to small-scale and commercial glasshouse trials. In the laboratory screening tests, materials were applied at various rates with β-naphthoxyacetic acid at 50 p.p.m. to dry sterile tomato petals affixed to suitable holders for inoculations and incubation. The small-scale glasshouse trials involved inoculation, in humidity cabinets, of developing fruits with attached petals. Of the materials tested, copper fungicides were notably ineffective; but several other therapeutants proved effective, though usually at 1½–3 times the strengths recommended for other diseases. Included among those tested were certain organo-mercurials, thiocarbamates, tetramethyl thiuram disulphide, 2,3 dichloro 1,4 naphthoquinone, 8-hydroxyquinoline sulphate and 8-hydroxyquinoline benzoate. Compatibility tests of promising materials were made on emasculated trusses of potted tomatoes. Only four of these materials at the effective concentration proved to be compatible with the hormone and did not damage the trusses. These were 'Fermspray' (ferric dimethyl dithiocarbamate), 'Zirospray' (zinc dimethyl dithiocarbamate), 'Phygon XL' (2,3 dichloro 1,4 naphthoquinone), and 'Thirospray' (tetramethyl thiuram disulphide).

Commercial glasshouse trials of selected materials were made on spring crops in which the first three trusses were treated as outlined above. In two of these trials heavy natural infection developed, and results showed the method—that is, application of a combined hormone-fungicide spray—to be successful. In one of these trials the use of 'Fermspray' (0·5 per cent) and 'Phygon XL' (0·15 per cent) reduced *Botrytis* fruit-rot by 73 per cent and 53 per cent respectively on the treated trusses. Neither of the treatments adversely affected yield or quality of fruit. Spray residues on mature fruit were negligible. A measure of the severity of infection in the house can be judged by the fact that an average of almost seven fruits per plant (approximately 25 per cent) were lost from the three treated trusses in the check plots.

Apart from effecting a considerable saving of fruit at small cost, use of this new combined hormone-fungicide technique greatly delays build-up of infection, thus reducing the chance of later epiphytotic development of *Botrytis*. Trials are proceeding with the above and other materials. Detailed results will be published elsewhere.

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Bact. coli as a Food Supplement

The idea of using micro-organisms as food supplements is now commonplace, and a great deal is known about the use of yeast and *Chlorella*. Experimental work carried out recently at these laboratories suggests that equal, if not greater, possibilities exist in the use of *Bact. coli* cultures. These researches have been concerned solely with the effect of the addition of *Bact. coli* to basal diets, and no attempt has been made yet to ascertain the biochemical background of the results.

The material used consisted of heat-killed whole organisms, without removal of endotoxin. The strain was one selected at random from a collection of calf scour strains. The culture medium was a simple synthetic one, with ammonia as a nitrogen source and glucose as a carbon source. The aeration technique employed has been described[1]. Batches of 100 litres of this culture yielded about 400 gm. of bacterial protein, calculated as N × 6·25.

Uniform groups of young rats were fed *ad lib.* on a basal diet containing 11·5 per cent of protein and consisting of barley meal 2 parts, bran 1 part and 0·5 per cent cod liver oil. The effects of supplementing this diet with fishmeal and bacterial protein were observed by weekly weighings over periods of 3 or 4 weeks. It was shown by repeated experiments that 5 per cent of *Bact. coli*

protein and 5 per cent of fishmeal protein produced equal and significant increases in weight gains. The optimum quantity of bacterial protein has not been determined, but it appears to lie between 2 and 5 per cent. Feeding of bacterial protein at a level of 1 per cent induced regular but retarded growth. Nevertheless a group consisting of five male and five female rats fed through life on this level bred normally, and four of the females reared normal litters.

It appeared probable from these experiments that *Bact. coli* protein could serve as a substitute for animal protein. Some indication was obtained, however, that when the bacterial protein diet was fed to very young rats, an improved growth-rate resulted if 1 per cent of fish solubles was added. ($P = 0{\cdot}1$, with groups of eight rats.)

The results of experiments on chicks suggest that there may be a fortunate combination of essential dietary factors in *Bact. coli* protein and fish solubles. When a basal diet containing 11·9 per cent of protein and consisting of barley meal, bran, 2 per cent grass meal and 0·5 per cent cod liver oil was supplemented with either one of these, grossly subnormal growth-rates were observed; but when both were added, the bacterial protein at 5 per cent and fish solubles at 1 per cent, the chicks grew from day-old to four weeks old at a rate significantly greater than control groups with fishmeal and fish solubles, and at the same rate as control groups fed on a well-known brand of chick mash. A group of 12 Rhode Island Red × Light Sussex cockerels was reared entirely on this diet and weighed an average of 5·0 lb. at 14 weeks, with one cockerel weighing 6 lb. The optimum percentage of bacterial protein for chicks has not been determined; but it is thought to be substantially less than the 5 per cent used in these experiments. It is known to be greater than 1 per cent.

It would appear, therefore, that cereals can be made into a chick-rearing ration by the addition of *Bact. coli*, fish solubles, cod liver oil, and grass meal. The economic advantages of such a diet in Britain are outstanding; the cod liver oil involves no change from current practice, and the grass meal and fish solubles are abundantly available in relation to the small amounts needed. Further, the fact that the peculiarly exacting demands of the chick can be met warrants the prophecy that diets based on *Bact. coli* protein for other farm animals could be evolved with little difficulty.

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Inter-relations between Filarial and Malarial Infections in *Anopheles gambiæ*

The dual role of *Anopheles gambiæ* as a vector of both human malaria and bancroftian filariasis in Africa has long been established. Recently a curious relation between the two infections in the mosquito has come to light, for which there is no really satisfactory explanation.

In the course of routine dissections of wild-caught *Anopheles gambiæ* in Dar-es-Salaam, Tanganyika, during 1947–48, it was noted that while *A. gambiæ* had a high rate of infection with malaria parasites and with filaria larvæ, it was very rarely that one and the same mosquito was infected with sporozoites and mature filaria larvæ (Table 1), all mosquitoes being dissected one or two days after capture.

Table 1. Record of mixed infections of *A. gambiæ* with Sporozoites and Mature Thoracic Filaria Larvæ. (Dar-es-Salaam, 1947–48)

Total *A. gambiæ* dissected	Gland infections	Mature thoracic filaria larvae	Mixed infection
426	41	14	1

In this series of dissections mature thoracic filaria larvæ alone were considered, that is, those active larvæ which appear during routine extraction of the salivary glands; this stage is reached 9–10 days after the infective feed, and immediately precedes head infection in the mosquito. No dissections for head and proboscis filarial infections were made.

As the sporozoites appear in the salivary glands of the mosquito about ten days after the infective feed, and as the filaria larvæ take about the same period to reach the mature thoracic form, mosquitoes infected with either parasite have one important feature in common, namely, that they are at least ten days old, and probably older.

During 1952 further and more detailed observations were made in localities near Accra, Gold Coast, mosquitoes being examined not only for mature thoracic forms but also for the more advanced head and proboscis forms. The dissection record is shown in Table 2, most mosquitoes being dissected on the day after capture.

Table 2. Record of Malaria and Filaria Infections in *A. gambiæ* (Gold Coast, 1952)

Gland infections	
Number dissected	492
Number positive	15
Sporozoite-rate	3·1%
Filarial infections	
Number dissected	704
Number with all forms mature larvæ	28 (4·1%)
Number with head or proboscis larvæ only	9

Of forty-three wild-caught *A. gambiæ* positive for either sporozoites (15) or mature filaria larvæ (28), only two were found infected with both parasites.

Dissections for double infections with oocysts and mature filaria larvæ also revealed the rarity of mixed advanced infections (Table 3).

Table 3. Record of Mixed Infections of *A. gambiæ* with Mature Oocysts and Mature Filaria Larvæ. (Gold Coast, 1952)

Total *A. gambiæ* dissected for oocysts and mature filaria larvæ	499
Number with oocyst infections	28
Number with mature filaria larvæ	8
Number with mixed infections	0

It is not unusual to find *A. gambiæ* with sporozoites or mature oocysts also harbouring immature, stumpy, thoracic forms of filaria larvæ; but the scarcity of mixed advanced infections in mosquitoes which have this important age factor in common is difficult to understand.

In interpreting these findings in wild-caught mosquitoes, one has always to bear in mind the possibility that some of the filarial infections may not necessarily be of human origin—that is, *Wuchereria bancrofti*—a point long appreciated, and recently emphasized by Raghavan *et al.*[1]. In the present series of experiments it appears likely that the great majority of these filarial infections really are of human origin in view of *A. gambiæ*'s well-known association with man, and that the human population in both

areas had a fairly high infection-rate with *W. bancrofti*.

One possible explanation of these findings has been tested, namely, the suggestion that the parallel development of filaria larvæ and malaria parasites cannot normally proceed to maturity in the same mosquito. An unusual opportunity for testing this was provided by a five-year old African child who was a chronic infector with both *falciparum* malaria and *W. bancrofti*. On two occasions batches of laboratory-bred *Anopheles gambiæ* were fed on him at night between 9 and 10 p.m. Out of 49 *gambiæ* surviving for dissection from ten days onward, 15 were found infected with malaria or filaria; of that number 2 showed mixed infections of mature thoracic larvæ and mature oocysts, and one was infected with both sporozoites and mature filaria larvæ in thorax and head.

Although these mixed advanced infections appear to be so scarce in Nature, these experiments show that both infections can actually proceed side by side and that there is no physiological barrier to prevent one and the same anopheline picking up both infections from the human host, and in turn becoming infective with both parasites.

In trying to interpret these figures it must be remembered that when the malarial infection has reached the sporozoite stage in the salivary glands of the mosquito, the infection may persist there for many days or even weeks. With the filarial infection, however, the infective stages in the head and proboscis are fairly transitory, and within about fifteen days of the infective feed they may have left the mosquito without leaving any trace behind. When we find a mosquito with a sporozoite infection we know that it must be at least ten days old; but it may, of course, be a much older mosquito which has also acquired, developed and finally lost a filarial infection.

These observations form part of a much wider investigation into the relative importance of each human age group in the African village community as a source of malarial and filarial infection. It is hoped that the outcome of this work may provide a satisfactory explanation of this curious mutual exclusion of advanced malarial and filarial infections in *Anopheles gambiæ*.

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Pseudotuberculosis among Stock-Doves in Hampshire

During December 1952, many stock-doves were found lying dead under the trees where they normally roost in the Damerham–Martin district of Hampshire. They appeared to be in good condition, but post-mortem examination of forty-two of them showed that death was due to a virulent strain of *Pasteurella pseudotuberculosis*. There were small caseating nodules in the liver and spleen, both of which organs were slightly enlarged. The outbreak continued throughout December and January, but began to decrease in February.

In order to find what other species were carrying the infection, all birds and rodents found dead in the district were examined, and many others were shot for examination. These included seventeen wood pigeons, one lark, one redwing, twenty-seven jackdaws, seven rooks, three jays, one sparrow, nine rabbits, six hares and fifty-two grey squirrels, and the bacterium was recovered from the lark, one wood pigeon, one jackdaw, one rook and one hare. The lark had been picked up dead, and the liver showed a close network of caseating fibres which traversed the whole organ, while the spleen contained two outstanding nodules about the size of a pin-head. Bacteria were recovered from both organs. The other infections were found in shot animals and were cryptic, for no signs of disease were noted in any organ. An attempt to infect bantam chicks gave negative results.

Many bodies are sent to this laboratory for examination, and during this period the bacterium was recovered from a rabbit in Hertfordshire and from two pigeons from Norfolk.

This infection has been repeatedly reported from rodents and sporadically from birds, though more serious outbreaks have been described from turkeys[1], fowls and pheasants[2] and from ducklings[3]. We ourselves have isolated the bacterium from grey partridge, pheasant and bob white quail, the latter being a bird reared in captivity. On this occasion, however, there seemed to be little disease among rodents, and it is particularly interesting that the wood pigeons were not seriously affected, in spite of their close affinity to stock-doves. Though the number of wild birds examined was small, there is evidence that several distinct species may be reservoirs of infection.

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Storage of Unfertilized Rabbit Ova: Subsequent Fertilization and the Probability of Normal Development

Previous investigations[1-3] have shown that fertilized rabbit ova stored at 10° C. or at 0° C. for various lengths of time can develop into normal young when transferred into recipient rabbits. A recent experiment[4] has further demonstrated that freshly ovulated unfertilized ova can be kept at 10° C. or at 0° C. for 48–72 hr. without all losing their fertilizability when transferred into the Fallopian tubes of rabbits which had been bred twelve hours before. This communication reports the subsequent fertilization and the probability of normal development following the transfer of unfertilized ova which had been stored for certain lengths of time.

Unfertilized ova were obtained from the Fallopian tubes of superovulated albino rabbits. The ova were recovered 11–13 hr. after the hormone injection which induced ovulation. They were suspended in a mixture of equal parts of buffered Ringer solution and rabbit serum and were stored in small 'Pyrex' tubes, either

at 10° C. in a water-bath, or in ice at 0° C. after an initial 1-hr. acclimatization[1] at 10° C. Fertilizability of the ova was then tested (*in vivo*) after 6–7 and 30–31 hr. at either temperature.

Recipient does were non-albino (black-eyed). About half of them were artificially inseminated with sperm from albino bucks. Six to seven hours later ova were transferred and 25 mgm. of macrocrystalline progesterone was injected subcutaneously. This progesterone treatment was repeated eight days later. The other recipient does were mated with an albino buck, and also injected with ovulation-inducing hormone, 6–7 hr. before ova were transferred. In order to eliminate the ova of these recipient does, the large ovarian follicles were punctured at the time of ovum transfer and the fluid content of the follicles was evacuated by means of a capillary suction pipette. Ova stored at 10° C. were transferred to the left tube, and those kept at 0° C. to the right tube, of the same recipient doe.

Most of the does were killed, or examined at laparotomy, 20–26 days after ovum transfer. Their ovaries and uterine contents were examined, and the numbers of normal fœtuses and of degenerate embryos or placentæ were recorded. The result of the experiments is presented in the accompanying table.

Storage of Unfertilized Rabbit Ova and Subsequent Fertilization and Development

Storage temperature (°C.)	Storage time (hr.)	No. of recipients		No. of ova transferred	Normal development as percentage of ova transferred	Degeneration after implantation as percentage of ova transferred
		Total	Pregnant			
0°	6–7	9	5	73	11	7
	30–31	8	3	57	7	0
10°	6–7	10	6	69	3	4
	30–31	8	3	58	4	2
Control (No storage)		4	2	30	27	0

The probability of normal development is much smaller when the ova are stored before fertilization instead of afterwards (3–11 per cent survival when stored 6–31 hr., against 11–37 per cent after 24 hr. storage of fertilized ova[2]). Survival of fertilized ova was better at 10° C. than at 0° C.[2] (37 per cent as against 11 per cent after 24-hr. storage); but the present results show no statistically significant difference between the effects of storage at 10° C. and at 0° C.

The method employed in the present study is not the most efficient for the determination of fertilization and normal development, because the reproductive state of the recipient animal was not optimal, and thus a high proportion of recipients did not become pregnant. In those recipients of which the large follicles were broken, the corpora lutea were not fully developed and some of the broken follicles had failed to develop into corpora lutea when examined at autopsy. Thus the implantation and the development of embryos may have been hindered. In those recipients which were treated with progesterone, a method previously reported as successful in maintaining the development of transferred fertilized ova[5], the transportation of the spermatozoa and of the transferred ova, and the process of fertilization, may be disturbed.

Moreover, in the determination of the fertilizability of ova[4], it was reported that spermatozoa were often observed in the zona pellucida or in the perivitalline space and yet the ova were not fertilized. Since the nuclear configuration and the chromosome number of ova parthenogenetically activated following low temperature storage was very similar to that of a normal fertilized ovum[6] it seems that parthenogenetically developed ova with sperm in the zona pellucida might have been mistaken as fertilized in the previous report[4]. The difficulty of determining whether the stored ova were fertilized or parthenogenetically developed *in vivo* was further experienced under present experimental condition, when the ova were examined after transfer for one day. Although the possibility exists that many actually fertilized ova failed to develop, the proportion of ova which appeared to be fertilized (nucleated cells with sperm in zona pellucida) corresponds in no way with the proportion that underwent normal development. Thus two interpretations exist: (1) that previous estimations of the percentage of actually fertilized ova were too high; or (2) that cold storage of unfertilized ova has adverse effects on the physiological process leading to future development after fertilization.

Taking all these possibilities into consideration, the low percentage of development as reported here in the transfer of unfertilized ova would be expected.

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Respiratory and Digestive Anatomy of a Microhylid Tadpole, *Hypopachus aguæ* Stuart

Through the courtesy of Mr. L. C. Stuart, some specimens of tadpoles of the microhylid frog *Hypopachus aguæ* Stuart, from Guatemala, have been made available for dissection. The internal anatomy of tadpoles of this family is almost unknown, apart from some aberrant species[1] and a brief account of some others[2].

Features of special interest are as follows. (1) An œsophagus divided into two lateral halves by a partial septum arising from the dorsal wall and extending almost to the ventral wall; each half receives one of the two mucous feeding-cords which are formed in the posterior parts of the pharynx. (2) The presence of a 'manicotto' (so-called larval stomach), previously only known in *Rana*. (3) Reduced gills, with filaments only on the second and third arches; the reduction has, however, not proceeded to the extremes found in *Glyphoglossus* and *Calluella*, nor are the gill

filters so large as in those species; the filaments are arborescent, as in other microhylids, and not as in *Rana* or *Bufo*.

The animals are clearly highly specialized for microphagy, since the œsophagus, already small in comparison with that of *Rana* or *Bufo*, has its lumen still further reduced by the thick septum, so that only narrow mucous cords can enter. They appear well adapted for life in a normal pond, having neither the huge filters (with rudimentary gills) needed for life in oligotrophic waters, nor the well-developed gills (with small filters) needed for life in a puddle. They were found in such a pond.

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Hæmolytic Disease of New-born Pigs caused by Iso-Immunization of Pregnancy

Hæmolytic disease of the new-born is now well recognized in the human subject and is known to be due to iso-immunization of the mother by fœtal red cell antigens of the *Rh* group. Within the past few years the condition has been observed in foals[1,2]; but so far as we are aware, its existence as a naturally occurring disease has not yet been established in any other species, although the possibility of a comparable pathogenesis in other animals has been suggested.

The classic pattern of hæmolytic disease consists in the mating of serologically incompatible parents. As a result the fœtus inherits antigen from the father which is passed to the mother and against which she produces antibody. This antibody, which has power to destroy the red blood cells of the young animal, may, in favourable circumstances, pass back into the fœtus or it may become concentrated in the mother's milk. The clinical condition of icterus gravis neonatorum has long been appreciated in human as well as in veterinary medicine; but more recently it has come to be recognized as a common symptom of hæmolytic disease.

Recently, we have carried out investigations which establish the existence of hæmolytic disease in pigs, following serious losses among baby pigs within the first week of life on one large farm in the Midlands[3]. In a high proportion of cases there were no survivors from affected litters; although all piglets appeared to be healthy at birth, varying degrees of clinical jaundice became evident at about the forty-eighth hour, and it was usual for the entire litter to be dead by the fifth day. At autopsy, icterus of the skin, musculature and viscera were constant lesions, and it was common also to find congestion and enlargement of spleens, some of which were nearly black in colour. Perhaps the most striking feature at post-mortem examination, however, was provided by the quantity of blood-stained peritoneal fluid which was present in nearly all carcases, and this, together with the darkened urine, served to indicate the speed at which red blood cells were being broken down by maternal iso-antibody. In general, post-mortem findings provided evidence of acute disease and depicted rapidly progressing hæmolysis.

With the generous assistance of Dr. R. R. A. Coombs, of the Department of Pathology, Cambridge, it was possible to apply the serological techniques of *Rhesus* factor work to the diagnosis of the disease in pigs and to demonstrate the existence of iso-immunization. Citrated blood samples from affected piglets were subjected to the direct antiglobulin sensitization test (Coombs test), using anti-pig globulin serum prepared in rabbits. Rapid and complete agglutination was obtained of all samples. Parental blood incompatibility was shown also by well-marked reaction between serum from affected sows and the red cells of the boar.

Although in hæmolytic disease of the human infant due to iso-immunization, icterus gravis neonatorum is common, it is by no means constant, and the condition may provoke a wide variety of symptoms. Very little knowledge exists yet concerning the manifestations of the disease in animals; but it seems reasonable to assume that they may be as varied as those of man and that some well-known clinical entities, the cause of which is still obscure, may be shown to be associated with maternal iso-immunization. Much work needs to be carried out into this kind of disease in animals, for with the necessary information relating to blood groups of the various species might emerge knowledge which could lead to the avoidance of losses resulting from the mating of serologically incompatible parents.

Note added in proof. Since this article was written we have learned of the work of Szent and Szobó into hæmolytic jaundice of new-born pigs in Hungary[4].

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Paper Chromatography of Keto-Acids

Blood pyruvic acid estimations were being made in this laboratory, and it was important to test the specificity of the method employed. The acid was extracted as the hydrazone by the method of Friedemann and Haugen[1] (using toluene for the extraction) and the hydrazones chromatographed under the conditions which Altmann *et al.*[2] had found successful.

Human blood was deproteinized with 10 per cent metaphosphoric acid and analysed for pyruvic acid[1]; the final ice-cold sodium carbonate solutions of the phenylhydrazones were acidified with concentrated hydrochloric acid and extracted into ether, which was removed under reduced pressure.

The hydrazones from blood were run with the hydrazones of pyruvic acid, phenyl-pyruvic acid, α-ketoglutaric acid, acetoacetic acid and acetone, which were prepared by incubating the keto-compound with a 0·1 per cent solution of 2 : 4-dinitrophenylhydrazine in 2 *N* hydrochloric acid. The precipitated hydrazones were centrifuged, and the precipitates washed twice with 2 *N* hydrochloric acid and twice with water.

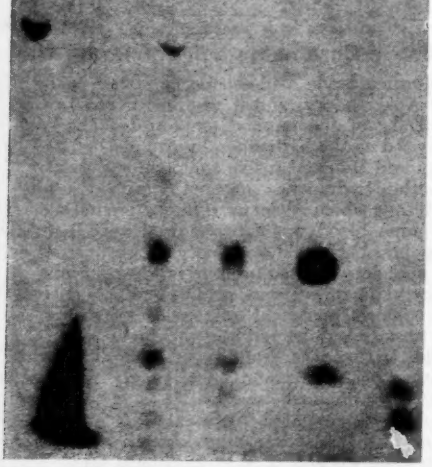
The chromatograms were photographed through a Wratten tricolour blue filter. The accompanying photograph illustrates the main findings. The average

R_F values for the hydrazones of some keto compounds from runs carried out at room temperature were :

α-Ketoglutaric acid	0·12
Pyruvic acid	0·58
Acetoacetic acid	0·60
Phenylpyruvic acid	0·84
Acetone	1·00

The hydrazones of blood were run on ten separate occasions, four spots always being observed. Two of these spots were accounted for by the hydrazone of pyruvate; but there were also two smaller, faster-running spots, which were barely visible until photographed. These latter were identified as the hydrazone of phenylpyruvate. The hydrazone of pure pyruvate gave two clear spots on all occasions. Yet when pure pyruvic acid was added to metaphosphoric acid and treated as for blood, the larger, slower-moving of the two spots often appeared to be divided into two. Partition chromatography of blood also frequently showed the same sub-division of the larger pyruvate spot. Since a blank of metaphosphoric acid also showed a spot at this level, this phenomenon is perhaps due to some 2 : 4-dinitrophenylhydrazine coming through the extraction process. It was also observed that acetoacetate hydrazone undergoes some decarboxylation to acetone during chromatography.

Cavallini, Frontali and Toschi[3,4] had previously carried out similar experiments, using a butanol–ethanol 20 per cent mixture as the mobile phase. They collected blood by the method of Long[5] and analysed it for pyruvic acid by Bueding and Wortis's modification[6] of Lu's[7] method. They found[4] that blood had two spots which they identified as α-ketoglutaric acid and pyruvic acid, and two unidentified spots, one with R_F 0·53, and another, which appeared occasionally, behind the solvent lines. They concluded that only about a third of the amount of keto-acid could be accounted for by pyruvate, the remainder being due to α-ketoglutaric acid and two unidentified compounds.



(*A*) Hydrazone of α-ketoglutaric acid. (*B*) Hydrazone of acetone (excess hydrazone was applied to the paper on this occasion; the spot usually lies on the solvent line). (*C*) Hydrazones from blood analysed for pyruvic acid as Cavallini *et al.* had done (ref. 4). (*D*) Hydrazones from blood analysed for pyruvic acid according to Friedemann and Haugen (ref. 1). (*E*) Hydrazone of pyruvic acid. (*F*) Hydrazone of phenylpyruvate

The specificity of the methods of extraction of Friedemann and Haugen[1] and of Cavallini *et al.*[4] were compared, using the solvents advised by Altmann *et al.* for chromatography (see photograph). Blood analysed as described by the latter showed one spot corresponding to α-ketoglutaric acid, two to pyruvic acid, two to phenylpyruvate, and a suspicion of two other spots, having R_F values 0·44 and 0·73. Blood analysed according to the former's method again showed only four spots, corresponding to pyruvate and phenylpyruvate hydrazones.

It would appear, therefore, that the method of Friedemann and Haugen allows separation of pyruvate together with some phenylpyruvate from the other keto-acids in blood in a way more specific than the method used by Cavallini *et al.* It is doubtful whether the paper chromatography of keto-acids can be made quantitative until the origin of the two spots for both pyruvate and phenylpyruvate is explained.

I wish to thank Prof. Charles Wells for his continued encouragement; Dr. S. P. Datta, of University College, London, for a gift of phenylpyruvate hydrazone; and Mr. Wilfred Lee, of the Central Photographic Department, University of Liverpool, for his co-operation in photographing the chromatograms. I also wish to acknowledge a grant from the Medical Research Council.

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A Chromatographic Colour Reagent for a Group of Amino-Acids

The condensation of aromatic aldehydes with amino-acids to give coloured derivatives has had limited use in paper chromatography. Ehrlich's reagent, *p*-dimethyl-amino-benzaldehyde, has been used as a reagent for tryptophane and indole[1] and for citrulline[2]. *o*-Phthalaldehyde has been used as a reagent for glycine, histidine and tryptophane[3]. Earlier workers have used other aldehydes, including vanillin, in strongly acid solution as reagents for tryptophane[4].

We find vanillin followed by alcoholic potash to be a chromatographic reagent of considerable specificity. One-way chromatograms are run on 20-cm. sheets in a Dent–Datta frame[5]. They are then dried and dipped in a freshly prepared 2 per cent solution of A.R. vanillin in *n*-propanol and heated at 110° for 10 min. Faint yellow colours are shown by many amino-acids at this stage. Ornithine gives a strong and lysine a weak green-yellow fluorescence in the ultra-violet.

The chromatograms are then dipped in 1 per cent alcoholic potash and heated again at 110° for 10 min. Ornithine gives a salmon spot about 30 sec. after commencing heating; the spot quickly fades to yellow-brown on further heating. This is specific for ornithine, none of the other compounds tested giving it. Proline, hydroxy-proline, α-, β- and γ-

pipecolinic acid, baikiain (Δ^4-tetrahydropyridine-2-carboxylic acid) and sarcosine show up as red spots after about six hours standing at room temperature and reach maximum intensity after standing overnight. β- and γ-pipecolinic acids give comparatively faint colours.

The complete range of commercially obtainable α-amino-acids gave either no colour or indefinite faint browns, with the exception of glycine, which gave a quite strong greenish-brown. This colour, however, is not easily distinguishable from the faint browns given by many amino-acids, and hence vanillin is not recommended as a glycine reagent. β-Alanine, β-amino-*iso*-butyric acid, γ-amino-*iso*-butyric acid, glutathione, betaine, hippuric acid, creatinine, glycocyamine, ethanolamine, pyrrole, pyrrolidine, pyrrolidone and indole also gave negative results. In general, the red spots only fade slightly in a week, though they tend to be obscured by darkening of the background in two or three days. Baikiain is an exception, becoming brown in about 20 hr. The background darkening is rapid after running the chromatograms in phenol, the spots also becoming discoloured. Results are satisfactory after running in butanol–acetic acid, collidine–lutidine or the acetone–urea–water solvent of Whitehead and Bentley[4]. The accompanying table shows the minimum detectable quantities of the substances giving well-defined colours in daylight when run on 15-cm. one-way acetone–urea–water chromatograms.

SENSITIVITIES OF AMINO-ACIDS TO VANILLIN

	μgm.		μgm.
Ornithine (30 sec.)	0·5	α-Pipecolinic acid (16 hr.)	1
Sarcosine (16 hr.)	0·5	Baikiain (16 hr.)	1
Proline (16 hr.)	1	β-Pipecolinic acid (16 hr.)	4
Hydroxyproline (16 hr.)	1	γ-Pipecolinic acid (16 hr.)	5

The use of a range of aldehydes and ketones as specific amino-acid chromatographic colour reagents is being investigated and will be described later.

We thank Dr. T. F. Dixon for helpful criticism and Dr. C. E. Dent and Mr. I. I. Smith for samples of various amino-acids.

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Detection of 5-Hydroxytryptamine by Paper Chromatography

IT is well known that enterochromaffin cells acquire a golden-yellow fluorescence after fixation in formaldehyde, due probably to their content of enteramine (5-hydroxytryptamine). We have now carried out chromatographic experiments with synthetic 5-hydroxytryptamine creatinine phosphate to study the sensitivity and specificity of this reaction. We used a butanol – acetic acid – water solvent and a developer composed of nine parts of a solution of potassium dichromate (0·1 per cent) and one part of formaldehyde solution (37–41 per cent). After spraying and heating at 100–110° C. for five minutes, the paper is viewed under ultra-violet light. Under these conditions, 5-hydroxytryptamine (R_F value 0·38) produces a golden-yellow fluorescence immediately after the heating and this persists for days; quantities as small as 0·2 μgm. base can be detected. The behaviour of bufotenine and bufotenidine is quite similar to that of 5-hydroxytryptamine. Tryptamine gives a bright yellow fluorescence if more than 2·5 μgm. are present; but this develops slowly. Tryptophane likewise gives a yellowish fluorescence if 2·5 μgm. are present, while 5-methoxytryptamine gives a yellow-orange fluorescence if similar amounts are present. Bufothionine, histamine, histidine, tyramine, tyrosine and *p*-norsynephrine produce no fluorescence, while that with adrenaline and noradrenaline is very feeble. *m*-Norsynephrine has already been shown to produce a violet fluorescence under these conditions if 0·5 μgm. is present[1]. Such a small amount of 5-hydroxytryptamine (0·2 μgm.) can also be detected with alkaline Folin reagent (producing a blue colour), Pauly reagent (red), diazotized *p*-nitraniline reagent (red-brown), N.N.C.D. reagent of Heinrich and Schuler (red-brown), Gibbs reagent (brownish-violet) and Ehrlich's reagent (blue)[2].

The fluorescent reaction may therefore be of value in tracing small quantities of 5-hydroxytryptamine in tissue extracts. The diazotized *p*-nitraniline reagent may also assist, since hydroxyindolealkylamines (for example, 5-hydroxytryptamine, bufotenine and bufotenidine) give an orange-brown colour whereas the indolealkylamines (for example, tryptamine) usually give a faint yellowish colour in higher concentrations.

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Quantitative Paper Chromatography of Traces of Metal with the Aid of Radioactive Hydrogen Sulphide

THE methods so far known for the determination of traces of metal are often expensive and take much time. Moreover, either the sensitivity is low or the error is large. On the other hand, quantitative paper chromatography has not developed far enough yet to give a competitive solution. I have investigated the possibility of using radioactive hydrogen sulphide ($H_2{}^{35}S$).

The quantitative reaction with radioactive hydrogen sulphide and the oxidation of the sulphides formed a first difficulty. This was solved in the following way. After chromatography, the dried papers are

conditioned over ammonia for half an hour. They are then put into a glass bell-jar which also contains some ammonia, some hydrazine and some radioactive zinc sulphide ($Zn^{35}S$). The jar is connected with a source of pure nitrogen and with the vacuum-line (both through gas-locks). After washing out the jar with nitrogen three or four times, vacuum is once more established. During this time a plastic shell is put over the jar and nitrogen is conducted through this shell. After adding some water and concentrated sulphuric acid to the zinc sulphide, the whole apparatus is put in the dark. After 10 min. the hydrogen sulphide is fixed by passing it through zinc acetate.

It appeared that 2 c.c. concentrated ammonia, 0·2 c.c. hydrazine hydrate, 3 mgm. radioactive zinc sulphide, 0·2 c.c. water and 0·2 c.c. acid are sufficient for the reaction of 100 μgm. of metal. The influence of the shape of the spot and the thickness of the paper were small.

It was necessary to wash the paper to remove metals retained in it. Successive washings with 0·1 *N* hydrochloric acid, water, 1 per cent sodium citrate and water removed most of the metals. For the determination of quantities of metal less than 1 μgm., this washing needs improving.

When applied to biological material, the method prohibits the use of sulphuric acid for breaking down the specimen, as this yields too high salt concentrations. For very small samples dry-ashing at 400° C. was sufficient; for samples of about 1 gm. the carbon residue had to be treated with ammonium nitrate and hydrogen peroxide; the residue was then taken up in hydrochloric acid.

For very small quantities of metal (cobalt), in order that a much greater proportion of the hydrochloric acid solution than usual could be transferred to the paper, we used a strip of paper (3 cm. × 12 cm.) folded like an accordion for absorption of the solution, and placed this pleated paper in the fold of a chromatographic paper between two glass rods. This is a variant of von Euler's[1] method.

All chromatography was performed by the ascending method, using jam-pots with paper cylinders held together by paper cuffs, for the quick selection of the correct solvents. For analysis larger cylinders were used, each placed in a Petri dish, and the dishes in a big glass tray. For the pleated papers broad sheets of paper were used, kept in the perpendicular position by sticking a glass pin through the upper part. It was found preferable to use the one-dimensional method, transferring each time new amounts of the same solution to a new paper, using different solvents for different groups of ions to be separated.

In view of the action of the ions potassium, sodium, calcium, phosphate and others always present in larger quantities in biological material, and also in view of the fact that non-evaporating complexes are not suitable, only the following solvents have been successful so far (all proportions being v/v):

Butanol-saturated with *N* HCl: for Mo—Zn and others.
Acetone (75 parts), 4 *N* HCl (25 parts): for Mn—Cu—Fe—Zn.
Pyridine (60 parts), H_2O (40 parts), followed by acetone (75 parts), 4 *N* HCl (25 parts), 1 ‰ KI: for Co ('accordion').

For thallium, mercury and tin several solvents already described in the literature were successful, and also:

Butanol (90 parts) with ethylaceto acetate (10 parts) saturated with 0·1 *N* HNO_3: for Hg, Sn, Tl; nitrates 'accordion'.
α-Picoline (60 parts), H_2O (40 parts): for Tl and Hg; 'accordion'.
Butanol (80 parts) with *tert.* butanol (20 parts) saturated with H_2O: for Tl; nitrates 'accordion'.

Further new suitable solvents were:
Pyridine (60 parts) 0·1 *N* HCl (40 parts); followed by pyridine (60 parts), H_2O (40 parts): for Mn.
CCl_4 (80 parts) with acetylacetone (20 parts) saturated with 1 *N* NH_4OH: for Cu.
α-Picoline (60 parts), 0·2 *N* NH_4OH (40 parts), 1 per cent diethylamine: for Mo.

The advantages of the method are: once the biological material is broken down, any metal can be detected and no concentration with oxine or suchlike is needed; the sensitivity is very great (comparable with spectrography); the method is not costly and can be carried out on a large scale and partly automatically.

A detailed description will be published elsewhere. I thank Mrs. C. J. H. Stutterheim-Kanis and Mrs. A. C. M. Peer-Borst for practical assistance.

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Paper Chromatography of Amino-Acids in Cerebrospinal Fluid

We have been investigating the amino-acids present in the cerebrospinal fluid obtained from patients with various diseases, using paper chromatography. Successful chromatograms require that protein and electrolytes should be removed from the fluid. There have been various methods suggested for doing this. We use a method which is simple, quick and requires apparatus that is readily available. It is based on the work of Boulanger and Biserte[1], who showed that, when biological fluids containing amino-acids are passed through cation-exchange resins, all the amino-acids with the exception of taurine are retained in the resin along with the cations, and that the anions pass through. The amino-acids can then be displaced from the resin with ammonia, leaving the cations on the column.

Boulanger and Biserte pass protein-free fluids through their suggested resin; but we have found as a result of Partridge's work[2] that, if a sulphonated polystyrene resin of the bead type is used, protein passes through unchanged. Thus in the one operation of passing the fluid through a suitable cation-exchange resin, proteins and anions are removed and the amino-acids retained. These may be displaced with ammonia and the resultant eluate evaporated under reduced pressure.

The method we use is as follows. The resin (Zeo-Karb 225) is activated with twice its volume of 10 w/v per cent hydrochloric acid, washed free of acid and then placed in a column approximately 15 cm. × 0·5 cm. The cerebrospinal fluid (1 ml.) is then passed through the column and 15 ml. of water used for washing it through. The amino-acids are displaced from the column with 15 ml. of *N* ammonia solution. The first 3 ml. of eluate are ignored. The next 12 ml. are evaporated under reduced pressure at 37° C. The dry residue is taken up in water and used for paper chromatography. The amino-acid arginine requires a much greater concentration of ammonia for its removal from the column.

We have shown that cerebrospinal fluids of high protein content can be passed through the column without the *p*H changes in the column altering the free amino-acid pattern of the fluid.

Combining this technique with the circular filter-paper method of paper chromatography suggested by Giri and Rao[3], we are able to obtain results within four hours of receiving the fluid in the laboratory. Actual bench-time is approximately thirty minutes.

Preliminary results show that the method is suitable for serum and urine.

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An Analysis for Deuterium based on the Photoneutron Effect

Indirect methods of measuring the abundance of deuterium involve chemical preparation and very careful purification of the samples[1,2]. This disadvantage and possible source of error is avoided in a method based on the $^2D(\gamma,n)^1H$ reaction for photon energies greater than 2·2 MeV. The number of neutrons emitted from the sample in conjunction with a suitable γ-ray source is a measure of the amount of deuterium present, and, under constant experimental conditions, a direct comparison with deuterium standards may be made.

A convenient source of γ-rays is a preparation of sodium-24 for which an initial activity of at least 40 mC. gm.$^{-1}$ of sodium carbonate is possible. Each preparation affords a useful and economic measuring period, the deuterium photoneutron reaction cross-section is relatively large ($\sim 16 \times 10^{-28}$ cm.^{2}), and at this energy (2·76 MeV.) beryllium is the only other element emitting photoneutrons. The samples must therefore be free from beryllium and also from elements, such as lithium, boron and cadmium, with large absorption cross-sections for thermal neutrons, as the photoneutrons are most efficiently detected after being reduced to thermal energies in a water or paraffin moderator. These conditions of purity should not be difficult to realize, especially in medical and biological work for which the method is primarily intended. Since the various sources emit neutrons having similar energy distributions, they may be compared without measuring the density integral of thermal neutrons within the moderator in each case. Single measurements at a standard position in the moderator are sufficient.

To estimate the overall sensitivity of the method, some measurements have been made using very dilute deuterium samples irradiated by γ-rays from sodium-24 and a shallow, boron-lined pulse-ionization chamber as neutron detector. From these results, to be published in detail later, a suitable apparatus has been designed and is under construction. It consists of an annular, boron-lined ionization chamber, 20 cm. long by 20 cm. external diameter, surrounding a 9-cm. diameter lead cylinder at the centre of which is the photoneutron source. This comprises a 10, 20 or 30 ml. sample in an annular glass container enclosing the γ-ray preparation. The lead is to reduce both the γ-ray 'noise' level of the chamber and the number of photoneutrons from the deuterium naturally present in the moderator. This moderator, of paraffin wax, surrounds the chamber to a minimum depth of 20 cm. and is contained by a substantial concrete shield. With this arrangement it is estimated that a 10-ml. sample containing twice the natural abundance of deuterium in water, that is, about 0·03 vol. per cent, and a 500 mC. source of sodium-24, will yield a counting-rate—which should be a linear function of deuterium concentration and γ-ray source strength—of about 500 min.$^{-1}$ above an estimated background of about 50 min.$^{-1}$. Thus, when a reasonable quantity of the sample is available, the sensitivity of the method appears to compare well with that of other techniques, and measurements within a few per cent should be made fairly easily.

This new method will be used initially for the measurement of total body-water in the human subject. For this purpose it should not be necessary to use doses greater than 20 ml. of deuterium, instead of the order of 100 ml. commonly employed[2].

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Infra-Red Dichroism in Synthetic Polypeptides

Fraser and Price[1] have recently made some interesting and fruitful suggestions concerning the origin of some of the prominent infra-red absorption bands in peptides and other substances which contain an amide group. They predict that the transition moment of the band which appears in proteins and synthetic polypeptides in the region 1,630–1,660 cm.$^{-1}$ (the C=O stretching mode with some contribution from the conjugated CN bond) should make an angle of about 20° with the C=O bond; details of the calculation are not given. They consider that this angle is sufficient to explain the low dichroism of the C=O band observed in the spectrum of poly-γ-benzyl-L-glutamate[2] (when the molecules of this polymer are assumed to be in α helices[3]).

The relation between the C=O valency bond and the transition moment of the C=O band has been examined experimentally in this laboratory, using acetanilide as a model compound. From this work it appears that the angle might be as high as 23°[4]. The transition moment is in the plane of the amide group and displaced from the C=O bond towards the direction of the line joining the N and O atoms. Bamford *et al.* point out that an angle of about 26° displacement is needed to agree with the dichroism observed in poly-γ-benzyl-L-glutamate.

Some information on dichroism of C=O and NH bands has recently been obtained from spectra of nylon 66, a material which is a better model for a polypeptide than acetanilide, in which the nitrogen atom is bonded to an aromatic ring which may affect the electron distribution of the amide group. A thin nylon specimen in which there was no complication from double orientation was obtained by grinding a

thick oriented monofil of circular cross-section. The spectrum was observed with polarized radiation from a selenium transmission polarizer of high performance, and dichroic ratios 3·1 and 4·1 were obtained for the 1,640 cm.$^{-1}$ C=O band and the 3,310 cm.$^{-1}$ band, respectively. These results show at once that the transition moments of these bands are not parallel, although the corresponding valency bonds are expected to be nearly parallel in amide groups[5]. This effect was not observed in earlier measurements with nylon 66 owing to insufficient orientation of the specimens used. Qualitatively, the lower dichroism of the C=O band compared with the NH band is in agreement with Fraser and Price's suggestions, and with the observations on acetanilide; but the effect is smaller than we should expect.

If we assume (*a*) that the NH transition moment is along the valency bond, (*b*) that the C=O bond is normal to the chain axis[6], and (*c*) that the bond angles of the amide group are as given by Corey and Pauling[5], then the observed dichroic ratios show that the C=O transition moment is inclined to the valency bond in the expected sense, but at an angle of 12°, not 26° as required to explain the dichroism observed in the polypeptide spectrum. This result is obtained by assuming that nylon 66 is made of oriented crystallites and a completely unoriented fraction. It makes practically no difference to the result whether the crystallites are assumed to have perfect orientation or a dispersion of ± 10° from the fibre axis (X-ray photographs show the dispersion to be not more than ± 6°). When the result, together with the above assumptions, is used for calculating the dichroism of the C=O band in the poly-γ-benzyl-L-glutamate specimen used by Ambrose and Elliott, we obtained the value 6·6. The observed value is 2·6 and we are left with a major discrepancy.

Only assumption (*a*) will be discussed here. The only observations which give information on the direction of the NH transition moment appear to be those of Newman and Badger[7] on the spectrum of N-acetyl glycine. These workers concluded from measurements of dichroism that the NH bond was in the plane of the amide group, and that the αC—N—H angle was 100° ± 10°. The selected value for this angle given by Corey and Pauling is 114°. If we accept Newman and Badger's result as meaning that the NH transition moment is inclined to the bond by an angle lying between 4° and 24°, the situation is made worse, for this inclination is in a sense which brings the C=O and NH transition moments more nearly parallel.

The basic question raised is not so much whether the Pauling–Corey α-helix can be reconciled with the observed dichroism of a polypeptide, but whether the amide groups in nylon, in simple molecules and in folded polypeptides, can retain substantially the same parameters. If they do, then it would appear necessary to assume that, nevertheless, the angle between the valency bond and transition moment in the C=O group (and possibly the NH group) varies from compound to compound. This could only arise from effects of the environment. Such an effect is to be expected in bands which correspond to almost forbidden transitions, where an external force field may have a considerable effect, but the strong peptide bands are not of this kind. Changes in the hydrogen bond could produce an effect; but, in the structures assumed for the various compounds considered, such changes are supposed to be small. If the direction of transition moment is really so sensitive to environment, then obviously existing theory is far from adequate. The other possibility, namely, that the amide group is less invariant than appears from results obtained with small molecules, can only be a speculation until other evidence is forthcoming.

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Angular Correlation of α-Particle and Conversion-Electron from the Decay of Ionium

Ionium decays with the emission of α-particles leaving the final nucleus $^{226}_{88}$Ra at various levels of excitation known[1] to lie at 70 keV., 200 keV. and 270 keV. above its ground-state. Conversion electrons emitted from radium nuclei have been identified as due, for the most part, to *L*-conversion of 70-keV. γ-ray[2].

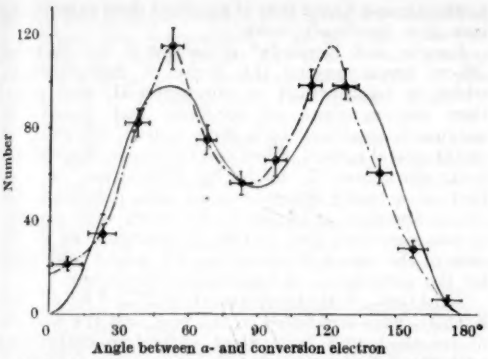
In the present experiment, we have investigated the distribution of the angles between the direction of the emission of the α-particles and of the conversion electrons by employing a continuously sensitive diffusion chamber operated at atmospheric pressure. Proper control of the vapour source, a mixture of 70 per cent ethyl alcohol and 30 per cent water, and of the gradient of the temperature, 7 deg. C./cm., gave tracks which were comparable with tracks of a Wilson chamber.

Freshly separated ionium was deposited along a wire which was fixed across the illuminated part of the chamber. The photographs, about 1,000 in all, taken at intervals of 15 sec., yielded 2,528 α-particle and 430 conversion-electron tracks. This gives 17 conversion electrons per 100 alpha disintegrations. Values obtained by different methods[1,2] were 24 per cent (Riou and also Jarvis and Ross), 11 per cent (Teillac) and 10 per cent (Albouy, Faraggi, Riou and Teillac).

Of the 430 conversion electron tracks, 336 cases could definitely be associated with α-particles. In many instances we observed electron tracks where no α-particles were to be found in the neighbourhood, although measurements of their energy showed that these unidentified electron tracks could be due to *L*-conversion of 70 keV. γ-rays.

In the accompanying graph we have plotted the distribution of the angles made by the α-particles and the conversion electrons. From the energy spectrum of the electrons observed in our experiment, it has been estimated that about 92·3 per cent are due to *L*-conversion and the remaining 7·7 per cent to *M*-conversion of 70-keV. γ-rays.

The theoretical calculations of Gellman, Griffith and Stanley[3], for the coefficients of conversion of the *L*-shell, show that most of the electrons emitted are from L_{II} and L_{III} sub-shells, while the contribution from L_I is negligible. Our measurements did not



Distribution of the angles between the direction of emission of the α-particles and the conversion electrons. The dotted curve gives the experimental results and the continuous curve is plotted from the expression : $54{\cdot}8-219{\cdot}2\ \cos^2\theta-274\ \cos^4\theta$

permit us to separate the L_I, L_{II} and L_{III} electrons, as their binding energies differ only by a small amount. It can be seen from the graph that the distribution is symmetrical about 90°, and the maxima are at 50° in the forward direction and 130° in the backward direction.

At present, no theory is available with which to compare our experimental results. The angular correlation of α-particles and *K*-conversion electron has been given by Rose, Biedenharn and Arfken[4] when the angular momentum of the intermediary state is known. If we assume[5] this to be 2, which is the angular momentum of the first excited state of the radium nucleus, then our experimental curve can best be fitted with the expression :

$$54{\cdot}8-219{\cdot}2\ \cos^2\theta-274\ \cos^4\theta.$$

We are indebted to Madame I. Joliot-Curie, of the Institut de Radium, Paris, for a gift of ionium which enabled us to carry out this experiment.

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Specific γ-Activity, the Branching Ratio and Half-life of Potassium-40

The specific γ-activity of ordinary potassium, in the form of 'AnalaR' potassium chloride, has been determined by the following procedure : (1) A source of potassium-42 (obtained by the irradiation of 'Specpure' potassium carbonate in the Harwell pile) was calibrated against a standard radium needle using a small carbon-walled ionization chamber. (2) The response was measured to a solution containing 1,745 gm. potassium (as 'AnalaR' potassium chloride), using a large differential high-pressure ionization chamber apparatus. (A description of this apparatus will be given elsewhere.) (3) A measured aliquot of a solution of the calibrated potassium-42 was added to the potassium chloride solution and the additional response observed as in (2). (4) The half-life of the potassium-42 was measured with the large ionization chamber apparatus and found to be (± probable error) $12{\cdot}516 \pm 0{\cdot}007$ hr. Analysis was by the method of least squares and each point on the decay curve was weighted on an experimental basis. It was necessary to correct for the presence of a small amount of unidentified long-lived activity with an apparent half-life of about 177 days. Sodium lines were reported in the spectrographic analysis, although the percentage contamination was not given ; the half-life result will therefore tend to be slightly greater than that of absolutely pure potassium-42, because of the presence of some sodium-24 of half-life 15·0 hr.

Corrections were applied for differences in attenuation in the wall of the carbon chamber between radium and potassium-42 radiations, internal absorption in the potassium-42 source and differences in the absorption of potassium-40 and potassium-42 quanta (1·46 and 1·51 MeV. respectively) in the solution and the steel walls of the ionization chambers.

In deriving the final result the following major assumptions were involved : (1) The dose-rate from a point source of 1 mgm. radium filtered in all directions by 0·5 mm. platinum is $8{\cdot}2 \pm 0{\cdot}1$ r. hr.$^{-1}$ at 1 cm. (It is believed that measurements with small carbon chambers will slightly over-estimate this constant, because of the effect of the condensed state of matter upon the electronic stopping power[1], a factor which has hitherto been disregarded. Accordingly, greater weight is given to the 'free air' determination of Taylor and Singer[2]. This problem will be discussed in detail elsewhere.) (2) The potassium-40 quantum energy is $1{\cdot}46 \pm 0{\cdot}01$ MeV.[3]. (3) The dose-rate per mC. of a point source of 1·46-MeV. radiation at 1 cm. is $7{\cdot}65 \pm 0{\cdot}12$ r. hr.$^{-1}$. (The greatest uncertainty in calculating this figure is in the value adopted for *W*, the average energy required to form one ion pair in air. This was taken to be $32{\cdot}5 \pm 0{\cdot}5$ eV.)

The value obtained for the specific γ-activity of ordinary (that is, unenriched) potassium was (± probable error) $3{\cdot}37 \pm 0{\cdot}09$ quanta sec.$^{-1}$ gm.$^{-1}$.

Evans and Evans[4], in a precise determination using as a reference source cobalt-60, calibrated by β—γ coincidences, found that 1 gm. of ordinary potassium emits $4{\cdot}9 \pm 0{\cdot}1$ MeV. sec.$^{-1}$. With $1{\cdot}46 \pm 0{\cdot}01$ MeV. as the quantum energy, their measurement yields $3{\cdot}36 \pm 0{\cdot}07$ quanta sec.$^{-1}$ gm.$^{-1}$. Other estimates include $3{\cdot}6 \pm 0{\cdot}3$ [5], 3·0 and 2·95 [6], $3{\cdot}6 \pm 0{\cdot}4$ [7], $3{\cdot}4 \pm 0{\cdot}5$ [8].

The branching ratio. Recent experiments[9,12] have demonstrated conclusively that the 1·46-MeV. γ-ray is associated with the electron-capture branch in the decay of potassium-40, and the measurements of Sawyer and Wiedenbeck suggest that perhaps all electron-capture transitions to argon-40 are accompanied by the emission of a 1·46-MeV. quantum.

Thus,

$$\frac{\lambda_\gamma}{\lambda_\beta} \leqslant \frac{\lambda\ (^{40}\mathrm{K} \rightarrow {}^{40}\mathrm{A})}{\lambda\ (^{40}\mathrm{K} \rightarrow {}^{40}\mathrm{Ca})}\ .$$

The weighted mean of the best measurements[5,10] of the specific β-activity of potassium is (± probable error) $27{\cdot}4 \pm 0{\cdot}3$ sec.$^{-1}$ gm.$^{-1}$.

Thus,

$$\frac{\lambda_\gamma}{\lambda_\beta} = \frac{3{\cdot}37}{27{\cdot}4} = 0{\cdot}123 \pm 0{\cdot}003 \text{ (} \pm \text{ probable error).}$$

Mousuf[11] measured the ratio argon-40 to potassium-40 for geological samples (assumed to be $1{\cdot}03 \times 10^9$ yr. old), and on the basis of a total half-life for potassium-40 of $1{\cdot}27 \times 10^9$ yr. obtained $\frac{\lambda\,(^{40}\mathrm{K} \rightarrow {}^{40}\mathrm{A})}{\lambda\,(^{40}\mathrm{K} \rightarrow {}^{40}\mathrm{Ca})} = 0{\cdot}053$–$0{\cdot}066$. There is thus a discrepancy amounting to a factor of 2 (at least) between this conclusion and that derived from the most reliable radioactivity data. It would seem likely that either the age of the samples has been over-estimated or argon-40 may have diffused out of them.

Half-life of potassium-40. If we regard all transitions of potassium-40 to argon-40 as being accompanied by the emission of a 1·46-MeV. quantum, we may assign an upper limit to the half-life of potassium-40. Nier[12] found the relative isotopic abundance of potassium-40 in ordinary potassium to be ($0{\cdot}0119 \pm 0{\cdot}0001$) per cent; using the values for the specific β- and γ-activities quoted above, we find $T_{1/2} < (1{\cdot}31_8 \pm 0{\cdot}04) \times 10^9$ yr.

This work was carried out as part of an investigation of the radioactivity of the human body, and was supported by the Medical Research Council.

Note added in proof. In the light of recent experimental work (Valentine, J. M., *Proc. Roy. Soc.*, A, **211**, 75; 1952) and other less direct evidence, the author is of the opinion that the currently accepted value for W (see above) of 32·5 eV. may be appreciably in error and that the true value for fast electrons may be as high as $35{\cdot}0 \pm 0{\cdot}5$ eV. If this latter figure should be substantiated, the above conclusions would need to be revised as follows:

Specific γ-activity of ordinary potassium (this research) = $3{\cdot}63 \pm 0{\cdot}10$ quanta sec.$^{-1}$ gm.$^{-1}$. Weighted mean of this and other determinations = $3{\cdot}48 \pm 0{\cdot}08$ quanta sec.$^{-1}$ gm.$^{-1}$. Branching ratio = $0{\cdot}127 \pm 0{\cdot}003$. Half-life of potassium 40 $< (1{\cdot}31 \pm 0{\cdot}04) \times 10^9$ yr.

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Szilard and Chalmers Effect by Irradiation of Hexavalent Chromium in an Atomic Pile

Muxart *et al.*[1] found that no rapid exchange of chromium takes place between hexavalent and trivalent chromium in solution. This has later been verified by Menker and Garner[2]. Muxart *et al.* used this result for investigating a possible Szilard–Chalmers effect in dichromate irradiated by slow neutrons, and found that if an effect does exist in this case it is extremely weak.

Burgus and Kennedy[3] investigated the chemical effects accompanying the decay of manganese-51, which is transformed to chromium-51, and found that the amounts of trivalent and hexavalent chromium produced to a large extent depended on the chemical milieu. Since certain tracer experiments with chromium-51, made by irradiation of solid CrO_3 in a heavy water/uranium pile, indicated that tracer amounts of trivalent chromium were present, it was assumed that similar phenomena, as in the case of the decay of manganese-51, might take place by the irradiation of hexavalent chromium.

Solid CrO_3, 6 *M* chromic acid, and solid $KCrO_4$ and $K_2Cr_2O_7$ were irradiated in the pile, and the activity of trivalent and hexavalent chromium determined with the following result:

CrO_3, solid	13 per cent	± 2	trivalent chromium activity
6 *M* solution of CrO_3	6 „	± 1	„ „ „
K_2CrO_4, solid	14 „	± 3	„ „ „
$K_2Cr_2O_7$, solid	1·5 „	± 1	„ „ „

The limits given for the percentage activity of trivalent chromium are estimated from the deviations of single experiments.

To make sure that the trivalent chromium activity was really due to chromium-51, the decay and the absorption in aluminium of the radiation from the trivalent and hexavalent chromium specimens were compared and found to be identical. The specimens also followed the chemical reactions of chromium.

A more detailed account of the investigations will be given elsewhere.

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Dependence of Glow to Arc Transitions on Cathode Surface Conditions

Earlier workers have shown that the relative stability of glow and arc discharges on both refractory and non-refractory electrodes is seriously affected by cathode conditions such as oxide layers[1], vapour clouds[2], salt contaminations[3] and temperature[4]. However, owing to the rapid destruction by the discharge of prepared cathode surfaces, it has not been possible in the past to determine in a positive manner the effects of cathode surface condition on the glow to arc transition process.

A technique has now been developed, however, in which a glow discharge is moved electromagnetically between two parallel rod electrodes and is thus brought on to a part of the cathode having a specially prepared surface. Observation then shows whether the change in surface condition produces a glow to arc transition. For example, with clean tungsten electrodes in free air the conditions are set so that the glow discharge may be moved along the full length of the electrodes any number of times without transitions taking place. By simply placing a few grains of common salt at one point of the cathode

surface and then moving the glow along the electrodes, it is found that a transition to an arc takes place at the point of contamination and that the arc reverts back to a glow when once past the region of contamination. Investigation also showed that by placing one drop of very dilute salt solution (10^{-5} gm./c.c.) on a clean cathode surface, transitions were repeatedly obtained at the point of contamination, indicating the extreme sensitivity of the discharge form to surface condition. As expected, transitions are induced by other low ionization salts, by the deposited salts from tap water and by grease contamination. Experiment showed also that transitions due to salts and grease can be induced on copper electrodes by this method of controlled contamination.

An attempt was made to induce transitions by deliberate local oxidation of both tungsten and copper, and although several methods of oxidation were employed no transitions were produced. Further experiments showed also that oxidation does not inhibit transitions taking place at a freshly cut groove. This apparent inconsequence of an oxidized surface, when contrasted with known experimental oxide effects, is most probably due to the determining effect of an already present atmospherically produced oxide layer, which, under the experimental conditions, cannot support a stable arc discharge. It is interesting to find however, that, with tungsten electrodes, layers of tungsten trioxide or tungsten powder produce transitions when operating near the transition point for clean electrodes, and that similar results are obtained with cupric oxide or copper powder on copper electrodes.

The experimental results obtained so far clearly indicate that comparable arc discharges may exist on typical thermionic or non-thermionic emitters, in agreement with other investigators[5]. The experiments also show that such arcs can be induced by minute surface contaminations and indicate, in agreement with the recent work of Prof. Llewellyn Jones[6], the important influence of surface condition upon the cathode discharge mechanism. A further investigation under oxygen-free conditions is being carried out.

I am grateful to Prof. J. M. Meek for the interest he has shown in the investigation and to Mr. W. L. Price for his experimental work. Acknowledgment is made to the Admiralty for permission to publish this note.

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Velocity of Sound in Air at Low Pressures

Some recent measurements[1] of the velocity of sound over an extended range of pressures have indicated that, while the velocity is independent of pressure down to pressures in the neighbourhood of 15 cm. mercury, a significant increase in velocity appears as the pressure is further decreased. At 5 cm. mercury the increase amounts to several metres per sec. In each case the measurements were made in metal tubes with audio-frequency sound. No acceptable physical explanation of this effect has been found. Because of the meteorological significance of these observations and their implication in supersonic aerodynamics, we have carried out a new determination of the velocity of sound in air at pressures down to 5 mm. mercury.

The method employed in this instance consisted of measuring the transit time of a pulsed sine wave between two condenser microphones mounted in the tube wall and separated by a distance of approximately four metres. The signals from the microphones after amplification were presented on the screen of a cathode-ray tube together with a standard ten-kilocycle timing wave-form. Time-base expansion was employed over the significant portions of the wave-forms to be measured so that it was possible to determine the transit time, approximately 12 millisec., with a precision of 1 microsec. Loudspeakers were mounted at each end of the tube and signals were transmitted from each speaker in turn, thus eliminating the effects of time delays in the microphone amplifiers.

Two tubes of different diameter were used. These were 10 metres long, so that reflexions from the distant end arrived too late to interfere with the observed signals. The loudspeakers were mounted on rubber, and tests made with the gas at a pressure of 10^{-5} mm. mercury showed that transmission along the metal wall of the tube was less than the microphone noise-level. The traces on the oscillograph screen were photographed and time-intervals computed with the aid of a travelling microscope. In order to avoid the effects of transients, measurements were made on peaks in the centre of the sine wave train.

The tube was pumped overnight at a pressure of 10^{-5} mm. mercury and filled with dry air free from carbon dioxide. The leak-rate of the tube was such that during the course of an experiment the increment of pressure was never greater than 0·02 per cent. The gas pressure was measured to 1 per cent and the temperature to 0·02 deg. C. Two series of measurements were made: one at a frequency of 250 c./s. with a tin-dipped steel tube 19·05 cm. in diameter, the other at a frequency of 1,000 c./s. with a bright steel tube 5·07 cm. in diameter.

The corrections appropriate to velocity measurements in tubes have been considered in detail by Henry[2]. The velocities observed were corrected first to 20° C., then for variation of gas imperfection[3] with pressure, attenuation and wall flexure. The velocities so corrected were plotted against the reciprocals of the square roots of the pressures, since the form of the Helmholtz–Kirchhoff tube correction predicts a linear relation between these quantities. The slight departures from linearity observed at the lowest pressures could be completely accounted for by the accommodation coefficient correction given by Henry. A least-squares fit was made for the velocity V_T in the tube as a function of the pressure p. For example, in the case of the 1,000 c./s. experiment:

$$V_T = 343{\cdot}39 \pm 0{\cdot}04 - (17{\cdot}21 \pm 0{\cdot}45)\, p^{-1/2} + (3{\cdot}34 \pm 0{\cdot}97)\, p^{-1}. \quad (1)$$

The value of the free-space velocity at 20° C. is thus 343·39 ± 0·04 metres sec.$^{-1}$; the corresponding value for 250 c./s. is 343·42 ± 0·13 metres sec.$^{-1}$. The generally accepted value[3] for 20° C. is 343·42 ± 0·07 metres sec.$^{-1}$.

The Helmholtz–Kirchhoff tube correction may be written

$$V_T = V\left(1 - \frac{c}{r\sqrt{np}}\right), \qquad (2)$$

where V is the free-space velocity, r is the tube radius, n is the frequency, and c is a theoretical coefficient determined by the physical characteristics of the gas.

The coefficient of $p^{-1/2}$ in equation (1) leads to a value of c which is (90·7 ± 2·7) per cent of the theoretical value. The corresponding constant for 250 c./s. is (93·5 ± 17) per cent of the theoretical value. These values are in accord with those found by Kaye and Sherratt[4] and Norton[5] at atmospheric pressure.

The coefficient of p^{-1} in equation (1) leads to a value of accommodation coefficient $f = 0{\cdot}34\ ^{+0{\cdot}11}_{-0{\cdot}07}$. This value of f is consistent with the data for the 250 c./s. experiments for the lowest pressures.

It appears, therefore, that the tube corrections given by Henry account for the observations with an accuracy of 1 in 4,000 (1,000 c./s.) and 1 in 3,000 (250 c./s.) over the whole range of pressure studied. Down to pressures of 5 mm. mercury there is no variation with pressure of the free-space velocity for the frequencies studied.

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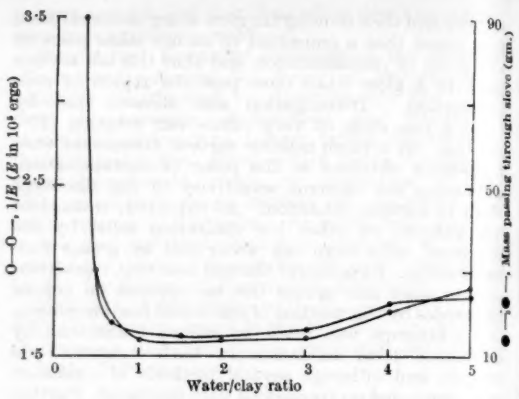
Method of Analysing Flow of Granular Materials such as Sand

I have been studying the flow of foundry moulding sand, and in the course of this work have developed a conception of flow of granulated aggregates which appears to simplify the problem and to permit relatively simple flow calculations. It is possible that these ideas might help in the treatment of data obtained for the flow of materials other than foundry moulding sands.

Foundry moulding sand may be briefly described as aggregates of clay-coated silica grains to which additions of coal dust, pitch and other organic materials can be made.

It has been found useful to consider flow in terms of the energy e used to coagulate an initially dispersed unit mass of sand, and E the energy required to redisperse or separate the grains again. The mathematical expression of flow is then based on the assumption that the energy needed to cause flow is used only in uniting and separating the grains.

The following is an example of the application of the idea to the flow of a sand through a sieve. A mass M of the material in the loose uncoagulated state is dropped from a height h on to a sieve. Some of the material is compacted on the sieve and is afterwards forced through the sieve by the remainder



of the sand falling on it. Let the amount passing through the sieve be m, then:

$$MgH = Me + mE,$$

but

$$e = f(D).$$

Where D characterizes the dimensions of the sieve and is constant for any particular sieve:

$$m \propto 1/E.$$

The accompanying illustration demonstrates the validity of this treatment. The values for E were obtained by the separation of two relatively large surfaces bonded with clay/water mixtures. These values are compared with values of m, obtained by dropping sand, bonded with the same range of clay/water mixture, from a fixed height on to a sieve and weighing the material passing through the sieve. The similarity of the two curves is clearly apparent.

The procedure outlined above can be used for determining the flow of granulated materials in various circumstances. I have examined the disintegration of agglomerates under impact, the behaviour of sand when propelled by a stream of air and flow of sand during a moulding operation. In each case the use of the principle has permitted an analysis which has good correlation with experiment.

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Differential Thermobalance: a New Research Tool

There are many models of thermobalances for making the curves, $p = f(t)$, of the loss of weight of a sample during heating. These suffer from the disadvantage that, if they are made automatic by an optical recording device, they sometimes produce records too small to display with sufficient precision the onset of reactions accompanied by a small loss of weight.

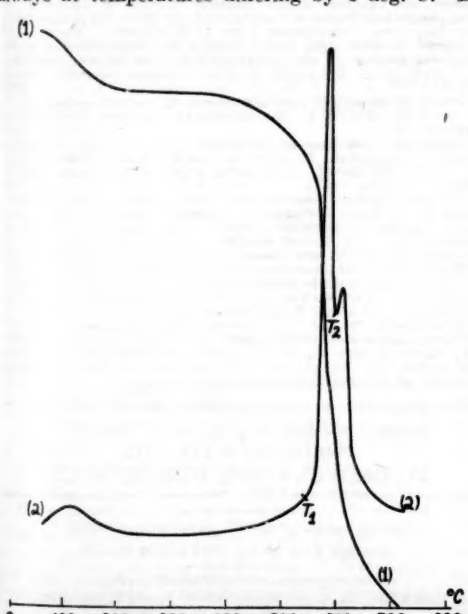
I have devised an apparatus which produces directly photographic records of the derivative

$$\frac{dp}{dt} = f'(t).$$

The differential, while giving a greater precision than integral curves, allows the results to be presented on a smaller scale. The accompanying figure shows the value of the method. Curve 1 is $p = f(t)$ for a mixture of 90 per cent kaolin of Zettlitz and 10 per cent diaspore. Curve 2 is the differential curve obtained by the new method. It is clear that the onset of the dehydration of diaspore (temperature T_2) is scarcely visible on the integral curve, although it is very clear on the differential. The curves thus obtained can be compared with those of differential thermal analysis and can be used alongside the latter. By comparing the results of the two methods it is, in fact, possible to distinguish peaks due to loss of weight from those which are due to endothermic reactions of another nature.

So far as the loss of weight is concerned, the advantage of the differential thermogravimetry over differential thermal analysis is that it is quantitative. Indeed, the loss of weight corresponding to each peak is proportional to the area contained between the curve and the abscissa. Because of this, it is possible to calculate, rather approximately, the composition of a mixture of various minerals. The advantage over ordinary thermogravimetry is that recording is easier and the precision is greater.

The automatic apparatus constructed by me consists essentially of two tubular electric ovens, a balance, an optical system and a drum for recording photographically curves such as (2) in the figure. During the analysis, the temperature of the two ovens is gradually raised, one being kept at a temperature 4 deg. C. lower than the other. On the trays of the balance are hung crucibles containing exactly equal quantities of the substance to be analysed. These crucibles, hanging in the ovens described above, are always at temperatures differing by 4 deg. C. By means of a mirror attached to the beam of the balance, it is possible, by a suitable optical system, to register the derivative dp/dt as a function of time (which is itself proportional to the increase of temperature).



Curve (1), $\Delta p = f(t)$; curve (2), $\Delta p/\Delta t = f'(t)$

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Comparative Philology and the 'Kon-Tiki' Theory

Neither in Mr. Heyerdahl's book[1], nor in Prof. Raymond Firth's review of it[2], is there any indication of the relevant philological state of affairs[3]. Yet, in considering whether the Polynesians came from America or from Asia, comparative philology affords an absolutely decisive disproof of Mr. Heyerdahl's theory. The evidence is easily put concisely in a set of three statements, namely :

(1) Two languages are defined as related if, and only if, they were once one language ; thus French and Spanish are related because, and only because, they were once Latin[4].

(2) If we develop statement (1), we readily reach the concepts (*a*) family of languages ; (*b*) parent language ; (*c*) related families of languages. Thus French, Spanish, Italian, etc., form the Romance family of which Latin is the parent ; English, German, Dutch, etc., form the Germanic family of which 'Primitive Germanic'[5] is the parent ; we may also say that Romance and Germanic are related, meaning thereby that their parent languages, Latin and Primitive Germanic, are related because they were once one language, Primitive Indoeuropean.

(3) It is accepted by philologists (*a*) that Polynesian is related to Indonesian[6] and (*b*) that no relationship subsists between Polynesian and any American language-family.

Two further points call for comment.

(*a*) The determination of linguistic relationship is a highly technical matter, requiring many years prior training in the rigid, algebra-like discipline of some specific branch of comparative philology (for example, that of Indoeuropean, Finno-Ugrian or Indonesian). Linguistic relationship is therefore not a subject on which the non-specialist is entitled to his own opinion.

(*b*) The chronology is of interest. Mr. Heyerdahl postulates two waves of 'Polynesians' coming from America, the first *c.* A.D. 500 from Peru, the second *c.* A.D. 1000 from north-west North America. But we possess written texts in Old Javanese (an Indonesian language) of at least the eighth century A.D. ; the period during which Primitive Indonesian was spoken obviously antedates these texts considerably.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY, Principal Scientific Officer grade (with first- or second-class honours degree or equivalent in physics or chemistry, and a proven interest in biological problems), at the Ministry of Supply Research Establishment, Field Trials Section, Salisbury, to design and supervise highly specialized forms of field trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A200/53A (August 29).

LECTURER IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Bristol, 8 (September 1).

ASSISTANT LECTURER IN APPLIED CHEMISTRY and an ASSISTANT LECTURER IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (September 7).

SCIENTIFIC OFFICER (with university degree in science or agriculture, and preferably with special qualifications in agricultural entomology) IN THE AGRICULTURAL ENTOMOLOGY RESEARCH DIVISION of the Ministry of Agriculture, to assist in advisory work and to carry out entomological research in connexion with the control of insect and allied pests of crops and livestock—The Secretary, Civil Service Commission, Stormont, Belfast, N. Ireland (September 7).

RESEARCH FELLOW (Junior) IN SOCIAL PSYCHOLOGY—The Secretary, The University, Aberdeen (September 12).

SCIENTIFIC OFFICER (with good honours degree (chemistry) and preferably with research experience) AT THE UNIT OF PLANT NUTRITION, Long Ashton Research Station, Bristol, for work on chemical problems concerned with the mineral nutrient status of plants, particularly trace elements—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (September 12).

ENGINEERS and PHYSICISTS (with first- or second-class honours degree or equivalent in electrical engineering or physics) IN THE ELECTRONICS DIVISION, Atomic Energy Research Establishment, Harwell, for duties ranging from fundamental research on circuitry and the physics of nuclear radiation detectors, to devising and developing (often in collaboration with industry) electronic devices for Atomic Energy Project—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.195/53A (September 12).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, The University, Sheffield (September 14).

LECTURER IN PHYSIOLOGY (graduate in medicine or science, and with postgraduate experience in some branch of physiology) at the University of Birmingham—The Assistant Registrar, Medical School, Birmingham 15 (September 15).

READER IN ANTHROPOLOGY at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 15).

RESEARCH FELLOW (with honours degree in physics) to undertake radio-isotope research in connexion with urological problems, especially those connected with urological malignant disease—The Registrar, The University, Leeds 2 (September 16).

RESEARCH OFFICERS (2), (*a*) (with university honours degree in agricultural science, or science, with specialization in agronomy or allied work, and preferably with postgraduate experience) to undertake research on pasture and crop establishment and development under irrigation, particularly on soils of heavy texture (Ref. 132/38); (*b*) (with honours degree in civil engineering, agricultural science, or science, with physics or geology as a major subject, or equivalent qualifications) to undertake research into the influence of irrigation and other practices on the hydrologic cycle especially on ground water table levels (Ref. 132/39), at the Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry Regional Station, Deniliquin, New South Wales, Australia.—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 19).

CIVIL ENGINEER (with at least 10 years experience in the design of civil engineering work and particularly reinforced concrete structures) (Ref. TT/675); ASSISTANT CIVIL ENGINEER (with experience in the design and detailing of reinforced concrete structures) (Ref. TT/676)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting appropriate Ref. No. (September 29).

DIRECTOR OF AGRICULTURE, Western Samoa, to take charge of the Department of Agriculture and advise the Government in the formulation of its agricultural policy and be responsible to the High Commissioner for all matters connected with its application—The Public Service Commissioner, Apia, Western Samoa (September 30).

PROFESSOR OF GEOLOGY at the Victoria University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 1).

PROFESSOR OF MUNICIPAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (October 1).

LECTURER IN BACTERIOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 2).

SENIOR LECTURER IN PSYCHOLOGY (preferably with qualifications in medicine, particularly psychological medicine) at the University of Melbourne, Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

CIVIL ENGINEERING ASSISTANTS IN THE WORKS DEPARTMENT at Admiralty establishments at Sheerness, Chatham, Yeovilton, Devonport, Culdrose, Leeds, Belfast and Rosyth—Civil Engineering Chief, Admiralty, Chamberlain Way, Pinner, Middlesex.

GOVERNMENT CHEMIST and an ASSISTANT GOVERNMENT CHEMIST in the Colonial Chemical Departments of (*a*) Uganda (Ref. CDE 97/9/01); (*b*) Nigeria (Ref. CDE 97/14/01)—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting appropriate Ref. No.

LECTURER IN DAIRYING (with qualifications in dairying or agricultural science, or science (chemistry and bacteriology)) at the School of Agriculture, Sutton Bonnington—The Registrar, The University Nottingham.

PHYSICIST (with university degree or equivalent qualification) for research on electric arc furnace problems (Ref. "Arc Furnaces"); APPLIED PHYSICISTS and RESEARCH ENGINEERS, senior and junior (candidates for senior posts should have an honours degree and two to three years research experience, and for junior appointments a degree or equivalent qualification) for research in industrial metal working processes, such as rolling and forging (Ref. "Metal Working"); and a PHYSICAL METALLURGIST (with university degree or equivalent) to carry out research on the ageing of mild steel (Ref. "Ageing of Steel") in the Sheffield Laboratories—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting appropriate Ref. No.

PHYSICISTS, SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent) or EXPERIMENTAL OFFICERS (with H.S.C. (Science) or equivalent) at Ministry of Supply Research and Development Establishments at Malvern, Farnborough, Sevenoaks and other outstations in Southern England, for work on aerodynamics and aircraft structures; armaments; instrumentation; radio and radar—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.170/53A.

PHYSIOLOGIST (with good honours degree in physiology or equivalent, and preferably with research experience involving the perfusion of isolated organs) for research on the physiology of lactation—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 53/3.

PHYSIOLOGIST (with honours degree in physiology and three or more years experience in physiological research) to undertake experimental work on the alimentary tract of the ruminant—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Medical Bulletin. Vol. 9, No. 2: Some Aspects of Enzyme Research. Pp. 85–168. (London: British Council, 1953.) 15*s.* [306

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 65, Part 1 (No. 8): Transuterine ("Internal") Migration of Fertilised Ova in the Albino Rat. By Dr. A. Young. Pp. 106+116+5 plates. 4*s.* 6*d.* Vol. 65, Part 1 (No. 9): Examples of Hybridization between two Species of Macaw (*Ara*). By Dr. L. Auber and Dr. W. C. Osman Hill. Pp. 117–120. 9*d.* (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) [306

World List of Bee Research Workers. Edited by Eva Crane. Pp. 40. (London: Bee Research Association Limited, 1953.) 5*s.* [306

British Commonwealth Scientific Office, North America. The BCSO Review of Science in U.S.A. for the year ending June 1952. Pp. Iv+40. (London: H.M. Stationery Office, 1953.) 2*s.* 6*d.* [306

Department of Scientific and Industrial Research. Food Investigation. Special Report No. 57: Dehydrated Meat. Compiled by Dr. J. G. Sharp. Pp. Ix+184. (London: H.M. Stationery Office, 1953.) 6*s.* net. [17

Other Countries

Canada: Department of Mines and Technical Surveys. Mines Branch. The Canadian Mineral Industry in 1950. Pp. Ix+148. 25 cents. Geological Survey of Canada. Memoir 269: Goldfields–Martin Lake Map-Area, Saskatchewan. By A. M. Christie. Pp. vii+126 (6 plates). 75 cents. (No. 2509.) Bulletin 25: Interpretations of the Structural Geology of the Sherridon–Flin Flon Region, Manitoba. By J. Kalliokoski. Pp. v+18. 50 cents. (Ottawa: Queen's Printer, 1952–53.) [296

German Hydrographic Institute, Hamburg. Annual Report No. 7, for the Year 1952. Pp. 84. (Hamburg: German Hydrographic Institute, 1953.) [296

Smithsonian Miscellaneous Collections. Vol. 121, No. 7: Studies of Arctic Foraminifera. By Alfred R. Loeblich, Jr., and Helen Tappan. Pp. Iv+150+24 plates. (Publication 4105.) (Washington: Smithsonian Institution, 1953.) [296

Fieldiana. Geology Memoirs, Vol. 3, Nos. 3 and 4. The Vertebrate Fauna of the Selma Formation of Alabama. Part 3: The Turtles of the Family Protostegidæ; Part 4: The Turtles of the Family Toxochelyidæ. By Rainer Zangerl. Pp. Iv+57–277+29 plates. (Chicago: Chicago Natural History Museum, 1953.) 6 dollars. [296

Proceedings of the American Academy of Arts and Sciences. Vol. 82, No. 3: Temperatures below one degree Kelvin. By C. J. Gorter. Pp. 157–166. 40 cents. Vol. 82, No. 4: The Supreme Court and the General Will. By Arthur E. Sutherland. Pp. 167–198. Vol. 82, No. 5: A Consideration of the Neurophysiological Mechanisms of Speech and Some Educational Consequences. By Wilder Penfield. Pp. 199–214. 45 cents. Vol. 82, No. 6: Records of Meetings from October 1952 to May 1953. Pp. 215–247. 75 cents. (Boston, Mass.: American Academy of Arts and Sciences, 1953.) [17

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